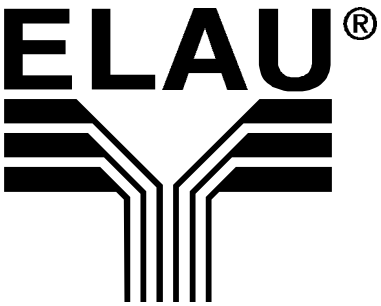

Project Manual

for

PacDrive S

Edition HB_PR * PMC-2 * EN * 07/97 Article number: 17130055-001

IMPRINT

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Contents

1 The Purpose of This Project Manual

This project manual is to support the planning of the mechanical switching cabinet construction and the electric system in the switching cabinet.

Further Literature:

PMC-2

- Product Information
  - German
  - English
- Project Manual
  - German Art.No. 17 13 00 55 – 000
  - English Art.No. 17 13 00 55 – 001
- User Documentation
  - German Art.No. 17 13 00 51
  - English Art.No. 17 13 00 52
  - Italian Art.No. 17 13 00 53
- Operating Manual PMC-2
  - German Art.No. 17 13 00 54 - 000
  - English Art.No. 17 13 00 54 - 001
  - Italian Art.No. 17 13 00 54 - 002
  - French Art.No. 17 13 00 54 - 003
  - Spanish Art.No. 17 13 00 54 - 004
- Operating Manual PMC-2 BASIC Soft
  - German Art.No. 17 13 00 56 - 000

Product Training

We also offer a comprehensive range of training programmes.

The training is done in our offices or, on request, at the customer's.

Training is available in German, English or French language.

The functions of the PMC-2 are explained not only in theory, but also in practice, based on the customer's specific situation. Solutions are developed in cooperation with the customer.

Please contact us for further information.

2 An Overview of the PMC-2

The digital positioning motor controller PMC-2 is the ideal cost-efficient and complete solution in future-oriented technology for your positioning and synchronising tasks.

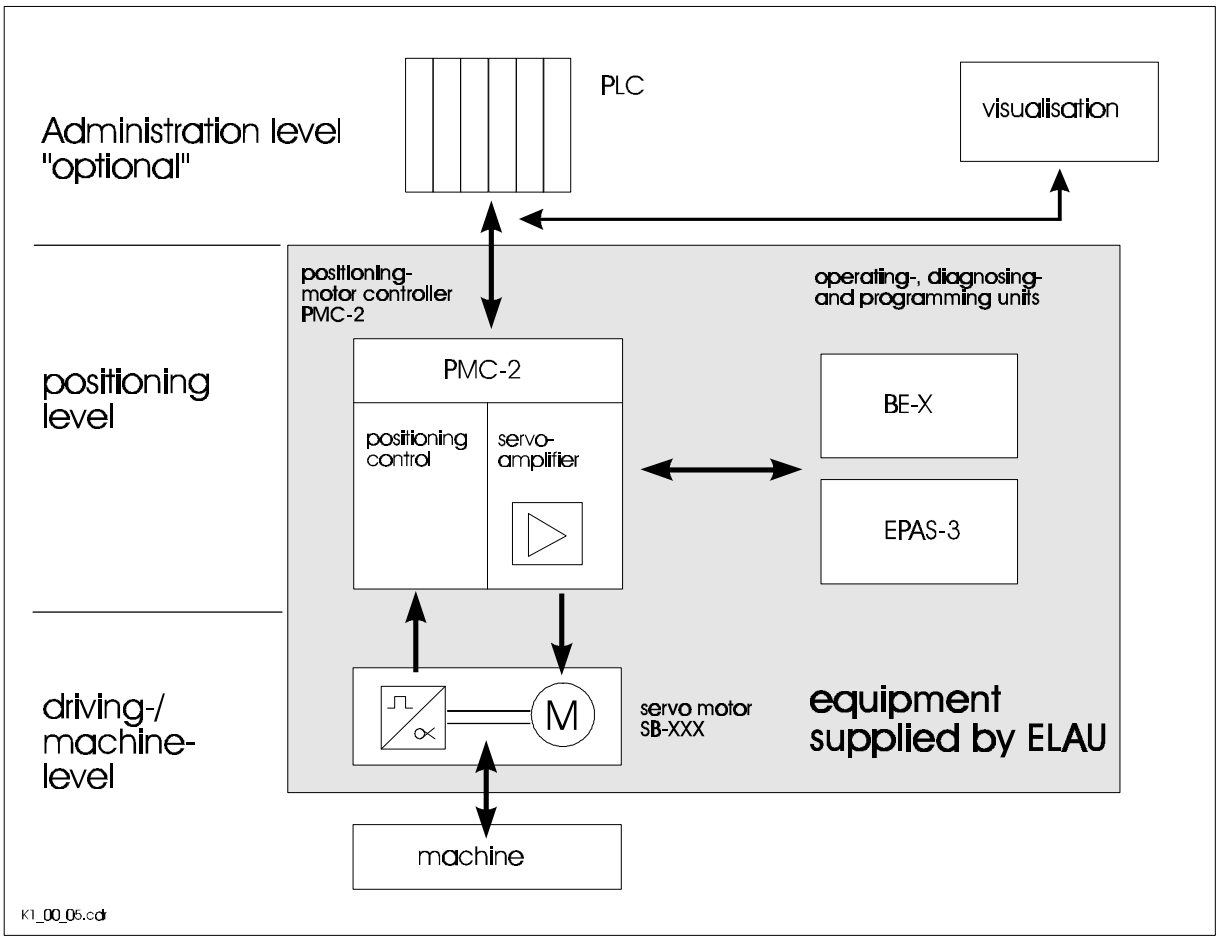
2.1 Introduction

Conventionally a servo positioning has been realised by means of a positioning controller and a separate motor controller.

The PMC-2 combines these two components all in one.

Advantages of this concept:

- No adjustment problems between positioning control and motor controller
- The system variable allows for a deep insight into the system, down to the motor current
- One software for complex positioning and synchronising tasks
- One interface for the parameter setting and programming of both components
- Highly flexible process language



Possible applications

All applications requiring the highly dynamical, flexible and precise positioning of brushless AC servo motors.

Typical applications can be found in tact and angle synchronous machines:

- Food and packaging machinery
  e.g. dosing plants, foil transport, cutting of brand-specific lengths, rotating blades
- Printing and paper machinery
  e.g. bookbinding
- Textile machines
  e.g. sewing, weaving, thread transfers
- Plastic machinery
  e.g. foil transport, cutting
- Hoisting engines and assembly systems
  e.g. round tables, palleting, feeding, removing
- Special purpose machinery
  e.g. flying shears, perforating installations

2.2 Performance Features

The positioning motor controller PMC-2 has the following features:

- flexible positioning control and digital motor controller all in one
- direct mains connection with integrated mains filter (600-Volt system)
- T1 operation according to VDI 2853
- DC-circuits of several PMC-2 can be switched parallelly (power compensation)
- completely digital concept
- multiple processor system (32-bit processor plus VECON chips)
- one programming interface for POS and MC
- unit exchange without PC (memory module)
- highly dynamic brushless AC servo motors SB-056 ... 205 in high-voltage technology with resolver or SinCos encoder
- comprehensive cross linkage abilities
- separate input and output levels (digital and analogue I/O's)
- independent operation
- optional modules for modular expansion
- connection of absolute or incremental encoders possible
- matured diagnosis
- simple and flexible programming language ECL-3 with multitasking functions
- system variable concept with deep system view down to motor current
- realisation of positioning and/or synchro functions (electric gearbox, disc cam function) with one software
- sampling rate of positioning controller 0.33 ms
- CE conformity

3 Safety

3.1 Explanation of Symbols and Notes

Safety Symbol

This symbol marks all safety notes in this operating instruction which may represent a life hazard. Please observe these notes thoroughly and be particularly careful in these cases. Also pass on all safety instructions to all other users.

Caution Note

CAUTION

This caution note marks points in this instruction which must be observed particularly carefully, so that guidelines, rules, orders, notes and the correct working process are adhered to and any damaging or destruction of the PMC-2 and/or other parts of the plant can be avoided.

3.2 Safety Information

for electrical equipment of machines for the machine manufacturer.

The machine manufacturer must carry out a danger, error and risk analysis for the specific conditions at his own machine, taking into account the valid safety regulations and corresponding safety facilities.
Safety is guaranteed if uncontrolled movements from standstill or during controlled drive can be avoided.
The safety arrangements must be done in such a way that no dangerous condition can occur in case of an error.
Regarding the safety of people, this can be achieved e.g. by preventing people from entering or reaching into the danger zone of the plant during operation (passive protection by means of blocked access, protective fences...).

The following norms, directives and rules, among others, are to be observed:

- DIN EN 60204 safety of machines: electrical equipment of machines (VDE-0113 part 1)
- DIN EN 292 part 1 and part 2 safety of machines: basics, general guidelines
- Universally valid rules for safety and accident prevention
- Set up operation is not allowed until it has been proved that the machine where the products are installed complies with the rules of EC directive 89/392/EEC (machine directive).
- Operation is only allowed if the national EMT requirements for the respective application are observed. In the EU, the EMT directive 89/336/EEC applies.
- DIN EN 50178 equipment of high-voltage plants with electronic operating means

3.3 General Safety Instructions

The following safety instructions must be observed with particular care:

- These safety instructions must be read and applied by all persons involved in the commissioning, operation, maintenance and repair of the machine.
- In addition to this operating manual, please observe the universally valid local and national regulations for safety and accident prevention.
- Before doing any work on the equipment, the plant must be switched currentless and secured against switch-on.
- After installation, commissioning or maintenance work on the electrical equipment and the machine, the protection measures provided must be tested.
- Omit anything that might affect the safety of the machine.
- Any unauthorised modification or manipulation of the equipment is prohibited for safety reasons.
- Those in charge of the plant's safety must guarantee that
  - only qualified staff are entrusted with the work on the appliances or machines
  - the instruction manual is available at all times and for all types of work and the workers are ordered to observe it consistently.
  - unqualified workers are forbidden to work on the equipment or machines.
- For work on the equipment, observe the corresponding notes on the equipment (e.g. front side, casing).
- The PMC-2 and the servo motor SB-XXX may be used only for the applications described in this manual and only in combination with external appliances and components recommended or approved by ELAU.
- The flawless and safe operation of the product requires appropriate transport, storage, set-up and installation as well as careful operation and maintenance.

3.4 Installation and Handling

There is a risk of injury due to squeezing, cutting or hitting!

Observe the rules for the prevention of accidents!

3.5 "Safely Separated Low Voltages"

Signal voltage and control voltage are <33 Volt and must be arranged as low voltages with safe separation. When installing the PMC-2 it must be ensured that the existing safe separation is maintained throughout the whole power circuit.

CAUTION

Wrong connection can lead to high voltages!

Observe the norms!
(draft DIN EN 50178/ed. 11.94, section 5.3.1.2)

3.6 Protection against Touching Electric Parts

Touching parts with tensions over 50 Volt can be dangerous for persons. When operating electric appliances, certain parts of these appliances inevitably carry a dangerous voltage.

CAUTION

Touching voltage-carrying parts - even after disconnecting them from the mains - is a life hazard!

Wait for >1 minute (due to the built-in capacitors) before accessing the appliances.

After removing the casing or touch protection, or after opening the system cabinet, certain parts of these appliances/systems become accessible which may carry a high voltage.

- After installation check the firm connection of the earth conductor on all electric appliances according to the connection plan.
- Operation is permitted **only** if the earth conductor is firmly connected to all electrical components. Otherwise high voltages may occur on the casing.
- Before accessing electrical parts with voltages exceeding 50 Volt, always disconnect the appliance from the mains supply or the power source. Secure against switch-on. If necessary, check the residual current in the DC-circuit (clamps DC+ and DC-) with a meter!
- Do not touch the electrical connection points of components while the appliance is switched on.
- Before switching on the appliance, safely cover up current-conducting parts to avoid contact.
- Provide for protection against indirect touch (according to draft DIN EN 50178/ed. 11.94, section 5.3.2).

 **CAUTION**	**The PMC-2 has an increased leakage current and may be operated only if an earth conductor is connected.** The leakage current exceeds 3.5 mA. Therefore appliances must have a firm mains connection (according to draft DIN EN 50178/ed. 11.94, section 5.2.11).

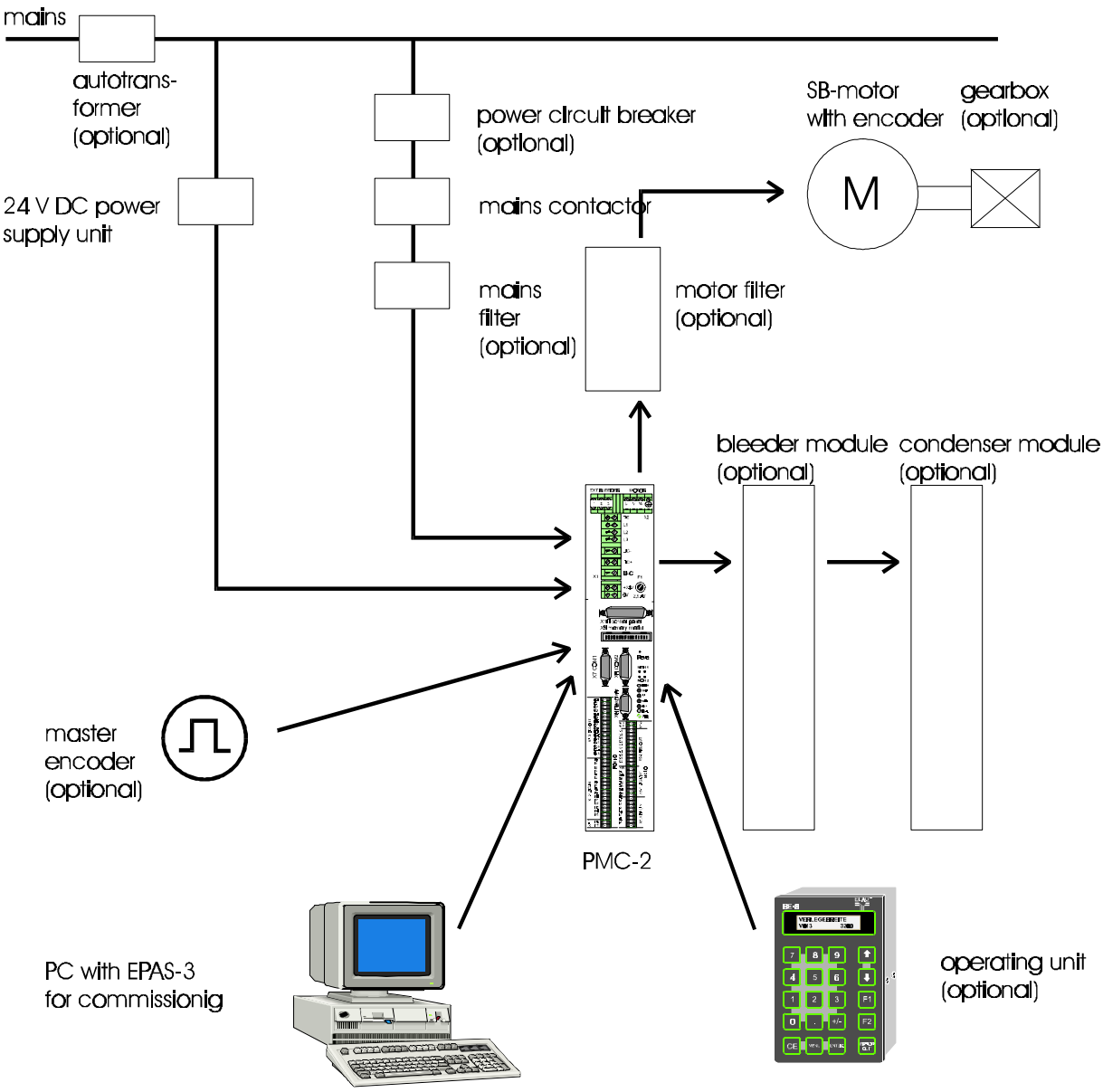
3.7 Protection against dangerous movements

There can be different causes for dangerous movements:
- Mistakes in wiring or cable connection
- Software errors
- Faulty components
- Errors of measuring value and signal encoders
- Operating mistakes

 **CAUTION**	**Dangerous movements!** Life hazard, risk of serious injury or material damage!

- The controls at the driving components to a large extent rule out malfunctions of the connected drives. However, these controls are not sufficient to protect people. Until the controls installed become effective, you must expect a faulty drive movement the extent of which depends on the kind of malfunction and the operating status. Therefore personal protection must be ensured by controls or measures superior to the plant. These are planned by the plant engineer with regard to the specific circumstances of the plant and after a risk and error analysis. The safety provisions of the plant are taken into account.
- No persons allowed within the motion range of the machine. This is to be ensured e.g. by means of protective fences, grids, covers or photoelectric barriers.
- The fences and covers must be sufficiently strong to resist the maximum possible motion energy.
- The emergency stop switch should be easy to reach and located very close to the operator. The functioning of the emergency off switch must be tested before start-up.
- Secure against unintentional start by enabling the mains contactor of the drives via an emergency off circuit or by using a safe start-up lock.
- Before accessing the machine or entering the danger zone, bring the drives to a safe stop.
- To work at the plant, switch the electrical equipment current-free via the main switch and secure against switch-on.
- Avoid operating high-frequency, remote-control and radio appliances in the vicinity of the plant electronics and connecting wires. If the use of these appliances is inevitable, check the system and the plant for possible malfunctions in all possible operating situations before first using the appliance. In some cases a special electromagnetic tolerance check of the plant may be necessary.

4 Which Components Are Needed?



Komponen.cdr

Which PMC-2 / SB motor combination is needed? see 4.1 ”Definition and Physical...”

- The drive must be dimensioned according to the required task.

CAUTION	We urgently recommend you to consult ELAU for the operation layout!

Data needed:

Designation	**Short**	**Value**	**Unit**
Required rated torque	M_{NA}	.....	Nm
Required peak torque	M_{SA}	.....	Nm
Rated motor speed	n_{NM}	.....	rpm
Load moment of inertia	J_{EXT}	.....	kgm^2
Brake		[ ] yes [ ] no	
Flange size		[ ] SB056 [ ] SB070 [ ] SB105 [ ] SB145 [ ] SB205	

- Choice of the PMC-2 / SB motor combination see 4.2 ”Combinations of PMC-2 ...”

  PMC-2/11/ _ _ e.g. PMC-2/11/05

  SB - _ _ _ _ _ _ _ e.g. SB - 105 30 02

Which other encoders are needed? see 4.3 ”Overview of Position and ...”

	Possible encoder combinations		**Required components**	
	Motor encoder	**Master encoder**	**Option module**	**Master encoder**
[ ]	Resolver	None	None	None
[ ]	SinCos	None	SCI-1	None
[ ]	Resolver	Incremental encoder	IKA-1	Incremental encoder
[ ]	SinCos	Incremental encoder	SCI-1	Incremental encoder
[ ]	SinCos	SinCos	SCI-1	SinCos encoder

Now you already know the order number for the SB motor.

SB - _ _ _ _ _ _ _ / 05 _ _ _ _ _ 64 / _ _ _ _

Order number **e.g.** **SB - 105 30 02 / 05 19 S 01 64 / E O KN**

1. Motor type
high-voltage AC servo motor

2. Motor Size Flange (mm)
056, 070, 105, 145, 205

3. Revolution nN (1/min)
e.g. 30 = 3000

4. Torque Mo (Nm)
e.g. 02 = 2 Nm
(for SB056 and SB070: 10 = 1Nm)

5. Flange design
05 = B5

6. Shaft diameter (mm)
SB-056 = 11
SB-070 = 11 SB-105 = 19
SB-145 = 24 SB-205 = 38

7. Shaft execution
S = without feather groove
P = with feather groove

8. Socket outlets
01 vertical catch
R1 vertical, catch right
L1 vertical, catch left

9. Protection type for the shaft
64 IP64
99 oil proof (for oil transmissions only)

10. Encoder feedback
E Resolver
D SINCOS SCM60 **without** resolver

11. Brake
O = without brake A = with brake

12. Ventilation
KN = without ventilation FL = with ventilation

Which other internal PMC-2 options are needed?

[ ] Optional modules		see 5.1.4
[ ] fast local bus	FLB-1	(to distribute master encoder values)
[ ] field buses		
[ ] PROFIBUS-DP	DPS-1	
[ ] INTERBUS-S	IBS-2	
[ ] analogue I/Os		
[ ] 2 inputs / 2 outputs	ANA-1	
[ ] 1 input	IKA-1	
[ ] internal bleeder		

Now you also know the position of the order number for the PMC-2.

PMC-2 / 1 1 / _ _ / 0 0 _ / _ _ / _ _ / _ _ / _ _ / _ _

Order number **e.g.** **PMC-2 / 11 / 05 / 0 0 0 / 00 / 00 / 01 / 00 / 0 K**

1. Positioning motor controller type
PMC-2

2. Serial number
series 11: 11

3. Rated current I_N

4A:	04
5A:	05
8A:	08
16A:	16
25A:	25

4. Execution

C: Rated voltage 3AC 400V		0
D: Protection type IP20		0
E: Bleeder	- with bleeder	0
	- without bleeder	1

5. Optional modules on POS connector position "I/O's"

without options	00
with ANA-1 ±10V input	01
with ANA-1 0 ... 20mA input	02

6. Optional modules on POS connector position "Communication"

without options		00
DPS-1		03
IBS-2	(incl. ES-3)	04

7. Optional modules on MC connector position "Encoder"

without options			00
IKA-1/±10V input		INC-OUT	05
IKA-1/±10V input	+ES-1	INC-OUT + INC-IN	06
IKA-1/±10V input	+ES-2	INC-OUT + ADW	07
IKA-1/±10V input	+ES-1 +ES-2	INC-OUT + INC-IN + ADW	08
IKA-1/0 ... 20mA input	+ES-2	INC-OUT + ADW	09
IKA-1/0 ... 20mA input	+ES-1 +ES-2	INC-OUT +INC-IN + ADW	10
SCI-1		for 1 SINCODER/SINCOS	11
SCI-1	+ES-1	for 1 SINCODER + INC-IN	12
SCI-1	+ES-4	for 2 SINCODER/SINCOS	13

8. Optional modules on MC connector position "System"

without options	00
FLB-1 (incl. ES-3)	01

9. MEMORY module

with memory module	0
without memory module	1

10. Bleeder

Long and short form without bleeder	0
Short form with bleeder	K

Which additional components are needed?

[ ] Bleeder module	see 6.4.4 ”DC-Circuit”
[ ] DC-circuit short circuit	
[ ] Additional capacitor module	
[ ] Check EMT conditions	see 6.4.2 ”EMT”
[ ] Mains filter	
[ ] Motor filter	
[ ] Economising transformer	see 5.8 "Transformers"
[ ] Q1 earth conductor	see 6.4.3 ”Mains Connection”
[ ] K1 mains contactor	
[ ] 24V DC power supply unit	
[ ] T1 operation	
[ ] Diagnosis unit	see 5.9 ”Diagnosing unit BE-7”
[ ] BE-7	
[ ] Operating units	see 5.10 ”Operating units”
[ ] BE-1	
[ ] BE-8	
[ ] EPAS-3 programming software	see 5.11 "PC Software EPAS-3"
[ ] Gearboxes	see 5.2.3 ”Mechanical Data of the...”

Which cables are needed? **see 6. "Planning of the Switching.."**

Cables which are always needed:
[**X**] Motor cable
[**X**] Motor feedback cable (encoder)
- [ ] Resolver cable or
- [ ] SinCos encoder cable

Cables which are needed depending on the system layout:
[ ] Brake cable
[ ] Encoder cable
- [ ] SinCos encoder cable
- [ ] incremental encoder cable

[ ] Field bus cable
- [ ] PROFIBUS-DP
- [ ] INTERBUS-S

[ ] Cables for operating / diagnosis units
[ ] Cable for ”electronic vertical shaft (FLB) with bus termination plugs

4.1 Definitions and Physical Correlations

Definitions

I_{OM}	[A]	Standstill motor current Effective value of the motor current at standstill torque M_0.
I_{NM}	[A]	Rated motor current Effective value of the motor current at rated torque M_N.
I_{SM}	[A]	Peak motor current Effective value of the motor current at peak torque M_{SM}.
I_{NC}	[A]	Rated current of the PMC-2 Rated controller current (permanent controller operation S1).
I_{SC}	[A]	Peak current of the PMC-2 Peak current of the controllers for acceleration. Also effective value of the motor current at peak torque M_{SA}, which is provided for a short time by the drive combination.
J_M	[kgcm^2]	Moment of inertia The motor moment of inertia refers to a motor with resolver and without brake.
J_{total}	[kgcm^2]	Moment of inertia Total moment of inertia (motor and load)
K_M	[Nm/A]	Torque constant of the motor Quotient of standstill torque M_0 and standstill current I_{0M}. K_{M20} for 20°C K_{M100} for 100°C (parameter value)
m	[kg]	Mass Motor mass without brake and without ventilation.
M_O	[Nm]	Standstill torque of the motor Permanent torque (100% ED) at speed n_O. With an environment temperature of 40°C, and dependent on the thermal motor time constant, an excess temperature of 60°C is created at the motor casing.
M_{OM}	[Nm]	Standstill torque of the motor Permanent torque (100% ED) at speed n_O. With an environment temperature of 40°C, and dependent on the thermal motor time constant, an excess temperature of 60°C is created at the motor casing.
M_{OA}	[Nm]	Standstill torque of the drive (motor in combination with PMC-2) Permanent torque (100% ED) at speed n_O. With an environment temperature of 40°C, and dependent on the thermal motor time constant, an excess temperature of 60°C is created at the motor casing.
M_{NM}	[Nm]	Rated torque of the motor Permanent torque (100% ED) at rated motor speed n_N. Due to the losses depending on the speed, this value is less than M_0. With an environment temperature of 40°C, and dependent on the thermal motor time constant, an excess temperature of 60°C is created at the motor casing.

M_{NA}	[Nm]	Rated torque of the drive (motor in combination with PMC-2) Permanent torque (100% ED) at rated motor speed n_N. Due to the losses depending on the speed, this value is less than M_0. With an environment temperature of 40°C, and dependent on the thermal motor time constant, an excess temperature of 60°C is created at the motor casing.
M_{S3}	[Nm]	Torque for intermittent service S3 = 25% ED
M_{SA}	[Nm]	Peak torque of the drive (motor in combination with PMC-2)
M_{SM}	[Nm]	Peak torque of the motor The maximum torque which the servo motor can emit for a short time at the drive shaft.
n_{NM}	[1/min]	Rated motor speed Useable speed at rated torque. Revolution speed in neutral gear n_L and maximum mechanical revolution speed n_{limit} of the servo motor are higher.
P_{NM}	[kW]	Rated capacity of the motor Rated capacity of the servo motor according to rated motor speed n_N and rated torque M_N.
P_{NA}	[kW]	Rated capacity of the motor in combination with PMC-2
R_w	[Ω]	Resistance of a motor coil Resistance of a motor coil between phase and neutral point. R_{W20} at a coil temperature of 20°C R_{W100} at a coil temperature of 100°C
L_W	[mH]	Coil inductivity Coil inductivity at a coil temperature of 20°C
t_{accSM}	[ms]	Acceleration time Acceleration time of the motor without foreign moment of inertia from 0 to rated motor speed n_N with the peak motor current I_{SM}.
TK	[mm]	Graduated circle of fixing Graduated circle for drill holes for fixing.
A	[mm]	Constructional length Constructional length of the motor for a motor with resolver, with/without brake, without fan and additional revolution encoders.
C	[mm]	Shaft length
D	[mm]	Shaft diameter D = Shaft diameter of the smooth shaft
P	[mm]	Graduated circle of fitting Graduated circle diameter, fitting h6
P4.02	[A]	Parameter value ”max_current” for the combination of motor and PMC-2
P4.08	[A]	Parameter value ”nom_current” for the combination of motor and PMC-2

Physical correlations

Correlation between Torque and Current:

$M = K_M * I_{eff}$
- M in Nm
- K_M in Nm/O
- I_{eff} in O (effective value of the phase current)

Current:
$I_{eff} = I_{sumit}/1{,}41$
- I_{eff} and I_{summit} in A

Rated motor power:
$$P_{NM} = M_N * n_N * \frac{2p}{60}$$
- P_{NM} in Watt
- M_N in Nm
- n_N in rpm

Admissible switch-on time in AB operation (S3) at a playing time of 15 minutes:
$ED = (M_N/M_{S3})^2 * 100$
- ED in %
- M_N and M_{S3} in Nm

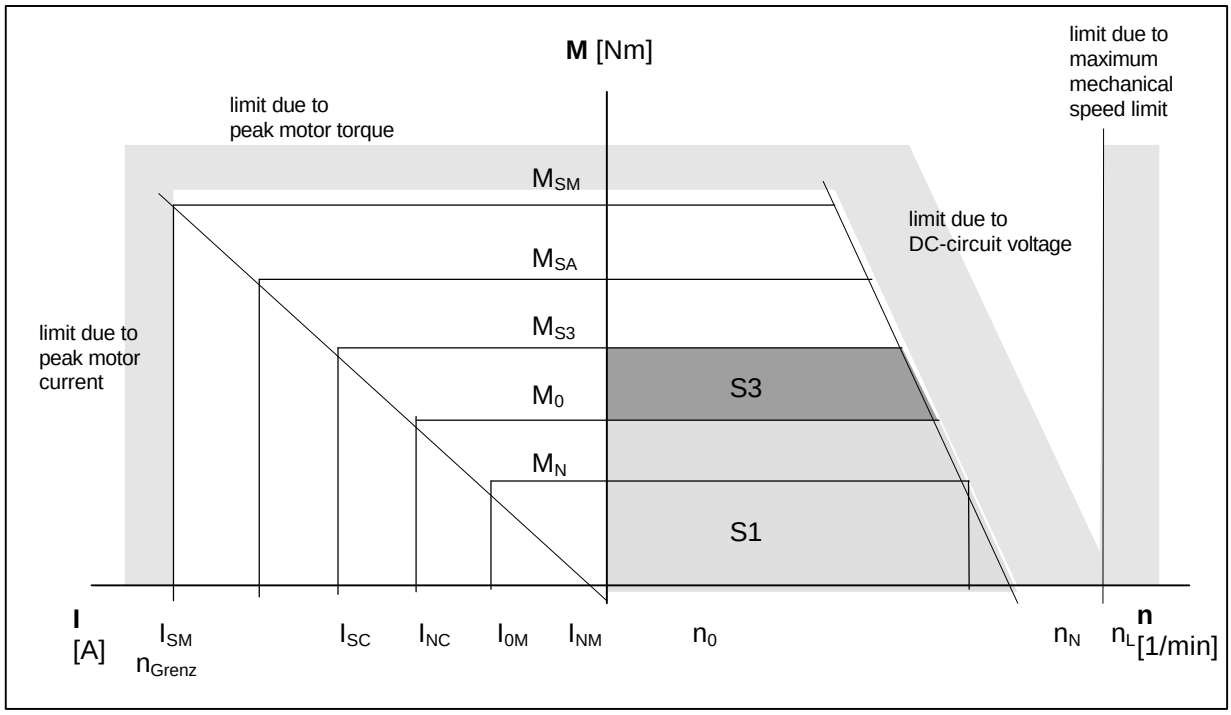
Effective torque at changing loads:
$M_{eff} < M_N$

$$M_{eff} = \sqrt{\frac{M_1^2 * t_1 + M_2^2 * t_2 + ... + M_n^2 * t_n}{t_1 + t_2 + ... + t_n}}$$

Motors peed:
$w = n * 2\pi / 60$
- w in rad/sec
- n in rpm

Moment of acceleration:
$M_{acc} = I_{total} * (w/t_{acc})$
- M_{acc} in Nm
- I_{total} in kgm^2
- w in rad/sec
- t_{acc} in sec (acceleration time)

Acceleration:
$a = w/t_{acc}$
- a in rad/sec^2
- w in rad/sec
- t_{acc} in sec


M [Nm]
limit due to peak motor torque
limit due to maximum mechanical speed limit
limit due to DC-circuit voltage
limit due to peak motor current
M_SM
M_SA
M_S3
M_0
M_N
S3
S1
I [A]
I_SM
n_Grenz
I_SC
I_NC
I_0M
I_NM
n_0
n_N
n_L
n [1/min]

4.2 Combinations of PMC-2 and SB Motors

Data for $T_{surround}$ = 40°C and ΔT_{Case} = 60°C

PMC-2/04

I_{NC} = 4A I_{SC} = 8A

Motor type	M_{OM}	M_{NM}	M_{OA}	M_{NA}	M_{SA}	n_{NM}	R_{W100}	K_{M100}	J_M	P_{NA}	P4.02	P4.08
	Nm	Nm	Nm	Nm	Nm	1/min	Ω	Nm/A	kgcm²	kW	A	A
SB 0565006	0.78	0.67	0.78	0.67	3.31	5000	29.230	0.92	0.21	0.35	3.6	0.732
SB 0704010	1.35	1.23	1.35	1.23	5.60	4000	20.888	1.12	0.40	0.52	5	1.101
SB 0704020	2.40	2.05	2.40	2.05	9.28	4000	8.539	1.16	0.68	0.86	8	1.764
SB 1053002	3.18	3.04	3.18	3.04	10.6	3000	12.093	1.51	1.9	0.96	7	2.016
SB 1053004	5.60	5.17	5.60	5.17	12.2	3000	4.473	1.53	3.4	1.62	8	3.381

PMC-2/05

I_{NC} = 5A I_{SC} = 10A

Motor type	M_{OM}	M_{NM}	M_{OA}	M_{NA}	M_{SA}	n_{NM}	R_{W100}	K_{M100}	J_M	P_{NA}	P4.02	P4.08
	Nm	Nm	Nm	Nm	Nm	1/min	Ω	Nm/A	kgcm²	kW	A	A
SB 0704010	1.35	1.23	1.35	1.23	5.60	4000	20.888	1.12	0.40	0.52	5	1.101
SB 0704020	2.40	2.05	2.40	2.05	9.28	4000	8.539	1.16	0.68	0.86	8	1.764
SB 1053002	3.18	3.04	3.18	3.04	10.6	3000	12.093	1.51	1.9	0.96	7	2.016
SB 1053004	5.60	5.17	5.60	5.17	15.3	3000	4.473	1.53	3.4	1.62	10	3.381
SB 1053006	7.76	6.95	7.65	6.95	15.3	3000	2.588	1.53	4.8	2.18	10	4.540

PMC-2/08

I_{NC} = 8A I_{SC} = 16A

Motor type	M_{OM}	M_{NM}	M_{OA}	M_{NA}	M_{SA}	n_{NM}	R_{W100}	K_{M100}	J_M	P_{NA}	P4.02	P4.08
	Nm	Nm	Nm	Nm	Nm	1/min	Ω	Nm/A	kgcm²	kW	A	A
SB 1053002	3.18	3.04	3.18	3.04	10.6	3000	12.093	1.51	1.9	0.96	7	2.016
SB 1053004	5.60	5.17	5.60	5.17	18.4	3000	4.473	1.53	3.4	1.62	12	3.381
SB 1053006	7.76	6.95	7.76	6.95	24.5	3000	2.588	1.53	4.8	2.18	16	4.540
SB 1053008	9.77	8.51	9.77	8.51	24.5	3000	1.793	1.53	6.2	2.67	16	5.559

PMC-2/16

I_{NC} = 16A I_{SC} = 32A

Motor type	M_{OM}	M_{NM}	M_{OA}	M_{NA}	M_{SA}	n_{NM}	R_{W100}	K_{M100}	J_M	P_{NA}	P4.02	P4.08
	Nm	Nm	Nm	Nm	Nm	1/min	Ω	Nm/A	kgcm²	kW	A	A
SB 1453008	11.7	10.9	11.7	10.9	38.2	3000	1.537	1.47	10.5	3.41	26	7.383
SB 1453015	20.5	18.0	20.5	18.0	51.5	3000	0.683	1.61	16.0	5.65	32	11.162
SB 1453022	28.4	23.6	25.8	23.6	51.5	3000	0.401	1.61	21.5	7.41	32	14.650

PMC-2/25

I_{NC} = 25A I_{SC} = 50A

Motor type	M_{OM}	M_{NM}	M_{OA}	M_{NA}	M_{SA}	n_{NM}	R_{W100}	K_{M100}	J_M	P_{NA}	P4.02	P4.08
	Nm	Nm	Nm	Nm	Nm	1/min	Ω	Nm/A	$kgcm^2$	kW	A	A
SB 1453008	11.7	10.9	11.7	10.9	38.2	3000	1.537	1.47	10.5	3.41	26	7.383
SB 1453015	20.5	18.0	20.5	18.0	66.0	3000	0.683	1.61	16.0	5.65	41	11.162
SB 1453022	28.4	23.6	28.4	23.6	80.5	3000	0.401	1.61	21.5	7.41	50	14.650
SB 1453028	38.1	30.0	38.1	30.0	80.5	3000	0.243	1.61	27	9.43	50	18.631
SB 2052050	65.1	60.7	56.8	56.8	113	2000	0.243	2.27	80	11.9	50	25
SB 2053027	36.5	33.7	34.8	33.7	69.5	3000	0.256	1.39	50	10.6	50	24.236

4.3 Overview of Position and Revolution Monitoring by Rotative Principles

Resolver, SinCos, incremental and absolute revolution encoder – you don't always have the principle of one system for way, speed or acceleration ready at hand.

In all rotating encoder systems linear measurements are referred back to a revolutional movement. The measurement is done either incremental or absolute.

Incremental Revolution Encoders

Incremental revolution encoders generate a certain number of impulses (Z) per revolution, which the positioning motor controller PMC-2 monitors and evaluates. The control does not recognise movements while the measuring system is in powerless condition. Two impulse channels are used in order to be able to recognise the direction of a movement: If channel A precedes channel B, this means a clockwise revolution, if channel B precedes channel A, the revolution is anti-clockwise. The direction is given from the point of view looking at the revolution encoder shaft. To generate a reference signal, there is a third channel. This channel is called zero signal, channel N or track N.
The resolution of these digital encoders cannot be set at any desired high level. The transmission behaviour of the rectangular signals limits the frequency range and thus the resolution. At 5,000 impulses and 3,000 min^{-1}, the transmission frequency is already 250 kHz. Commonly used resolution settings are 256 to 5,000 impulses, while the upper limit is around 10,000 impulses. If higher resolutions are needed, the signal can be doubled or quadrupled (evaluation of the impulse flanks). In the PMC-2 the signal is quadrupled.

Absolute Revolution Encoders

Absolute revolution encoders generate not just simple impulses, but complete data sets. The correct position is given even if the measuring system was moved in currentless state. Depending on the task, single-turn encoders with a maximum measuring range of 360° or multi-turn encoders with a measuring range of n*360° are used.

The single-turn is formed by a mass embodiment (glass, metal or plastic disc) which rotates inside the encoder. A specially designed scanner reads out the code disc. Resolutions of up to 13 bit ≈ 0° 2´38´´ are standard.

- To form the multi-turn encoder, manufacturers use different ways. The classical method is to cascade two single-turn encoders by means of a mechanical gearbox. Advantage: The number of revolutions as gear position is stored mechanically. Thus, this is a "real multi-turn absolute encoder". Due to the gearbox, the start-up moment is slightly increased, which can, however, be neglected in industrial machines.
- If a single-turn encoder is combined with a magnetic incremental encoder and a meter, a multi-turn encoder can be simulated. A battery is integrated so that the meter can work without external power supply. The self-discharge of batteries increases at temperatures above 40°C, which clearly limits the life depending on the surrounding temperature. As long as external power supply is applied, these multi-turn encoders work reliably even with an empty battery. Depending on the customer's wish, absolute encoder data can be issued in binary or GRAY code – other codes (e.g. BCD) are no longer up to date.

In the past absolute encoders were connected parallelly to the controls. With 25 bits plus power supply, this means at least 27 leads. Complex wiring, the high price of cables and the large number of potential errors led to serial interfaces frequently based on RS 485. The protocols offered vary between manufacturers.
In recent years mainly the synchronous serial interface (SSI) has been gaining ground as an interface for absolute encoders.

Disadvantages of these encoders:

- Dynamic signals are needed to determine the speed. Due to the serial transmission, however, these are too slow, so that an additional resolver is needed.
- Although there is no non-linearity at lower speeds, there is a major scaling effect due to the increment formation and the too low resolution. Therefore this system is not suitable for extremely slow speeds.

Resolver

Rotor position encoders for block or sinus commuting are common in electric machines. The revolving field in the motor is no longer controlled by carbon brushes and single commuting fields, as it used to be, but by a sensor, which measures the position of the rotor relative to the stator. Partly serious disadvantages, such as brush fire, loosening of the carbon or pollution of the commutator, can thus be avoided. Initially simple systems on a Hall element basis were used for block commuting. In this case it was completely sufficient to switch on and off the stator coils one after the other, particularly since the block-like development of the torque was already familiar from conventional commuting. However, if a steady torque is to be generated, it is no longer sufficient to switch the coils on and off individually, one after the other. A sinusoidal field is needed – this is called sinus commuting. Resolvers have been, and still are, used for this purpose.
In principle, the resolver is a transformer consisting of a static and a rotating coil. It is fed with an exciting frequency by an external measuring device, so that the rotor position can be measured even at standstill. Depending on the twisting angle between rotor and stator, the resolver emits one sinus and one cosinus per revolution. The measuring electronics process the analogue signal and provide the angle or position signal needed for commuting. In addition, an incremental signal with up to 2048 increments is issued. After multiplication, 8192 steps are available for torque regulation.

SinCos

Modern machines require far higher resolutions than can be provided by resolver, incremental encoder or absolute value encoder (SSI). In order to saturate this immense need for information, special revolution encoders and protocols were developed.

A rough description gives an insight in the functionality of these encoders.
Before starting a machine, the control requests the encoder to transmit its actual absolute position. To avoid extra wiring, this is transmitted serially. The position of the rotor in relation to the stator is thus known, the electric machine can be targeted optimally. From now on, this absolute information is no longer of interest, only the relative information is needed. The absolute encoder is set to sinus incremental mode and now emits analogue signals. Usually between 256 and 4096 sinus periods per revolution are transmitted. Signals can thus be transmitted at a non-critical frequency. The PMC-2 interpolates the position values from the sinus periods with a resolution of up to 12 bits. Thus resolutions of 4096x4096 = 16,777,216 steps per revolution can be achieved. To recognise the direction of revolution, a 90° phase-deferred signal, the cosinus, is emitted.

The ”hyperface” is a common protocol for this case.

Overview of Encoder Systems for the PMC-2

ELAU does not recommend the SSI encoder for the following reasons:
- It is more expensive than the SinCos encoder
- It is larger than the SinCos encoder
- The SinCos encoder has a higher resolution

Motor encoder:

Encoder	Increments / revolution	Revolutions
Resolver	8,192	1
SinCos	4,096 – 65,536	1 or 4,096

Master encoder:

Encoder	Increments / revolution	Revolutions
Incremental encoder	max. 40,000	-
SinCos	4,096 – 65,536	1 or 4,096

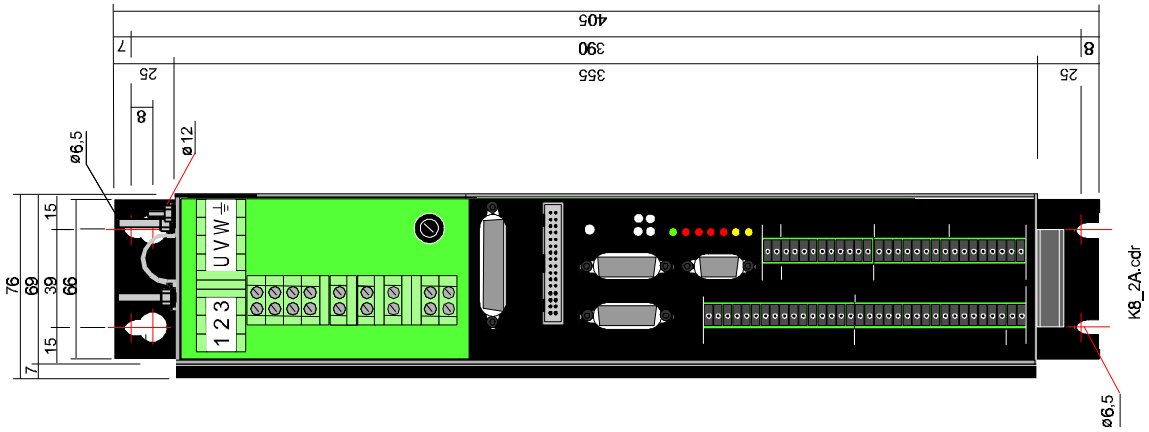
5 Components

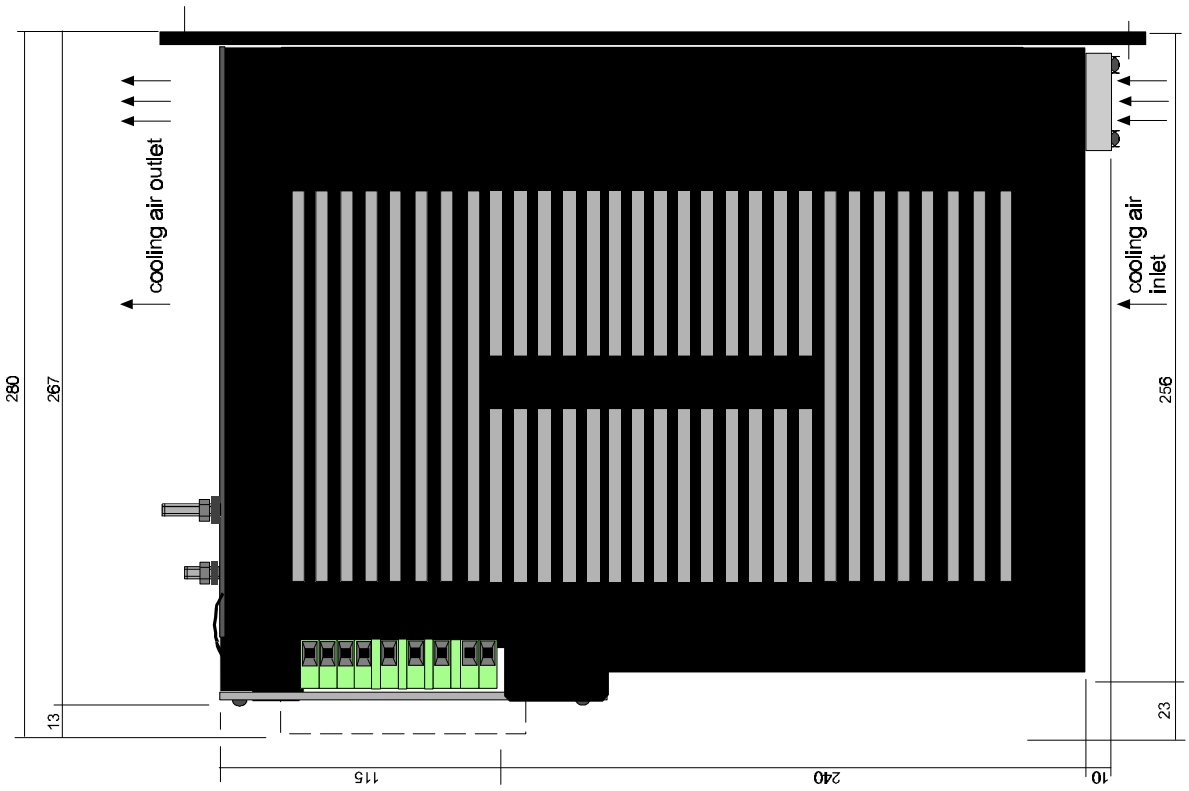
5.1 PMC-2

5.1.1 Plans and Measurements of Casings

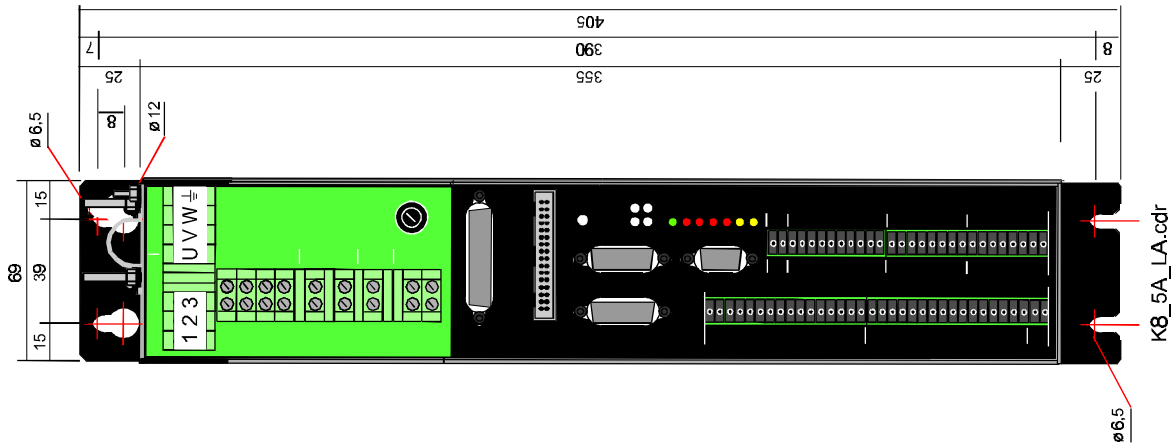
PMC-2/4A Short Form without Bleeder

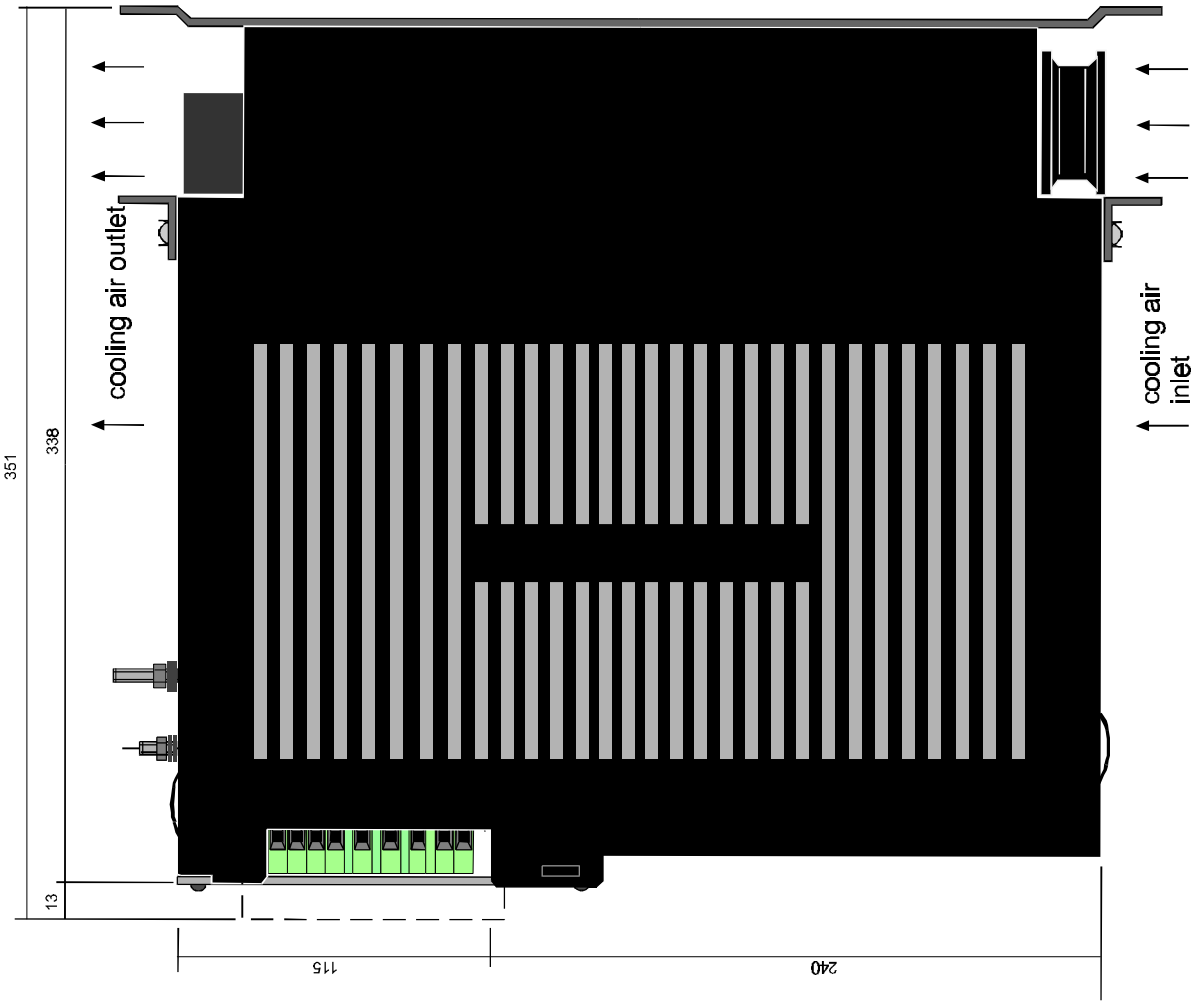
CAUTION	An external bleeder is absolutely necessary to operate this PMC-2 base unit.



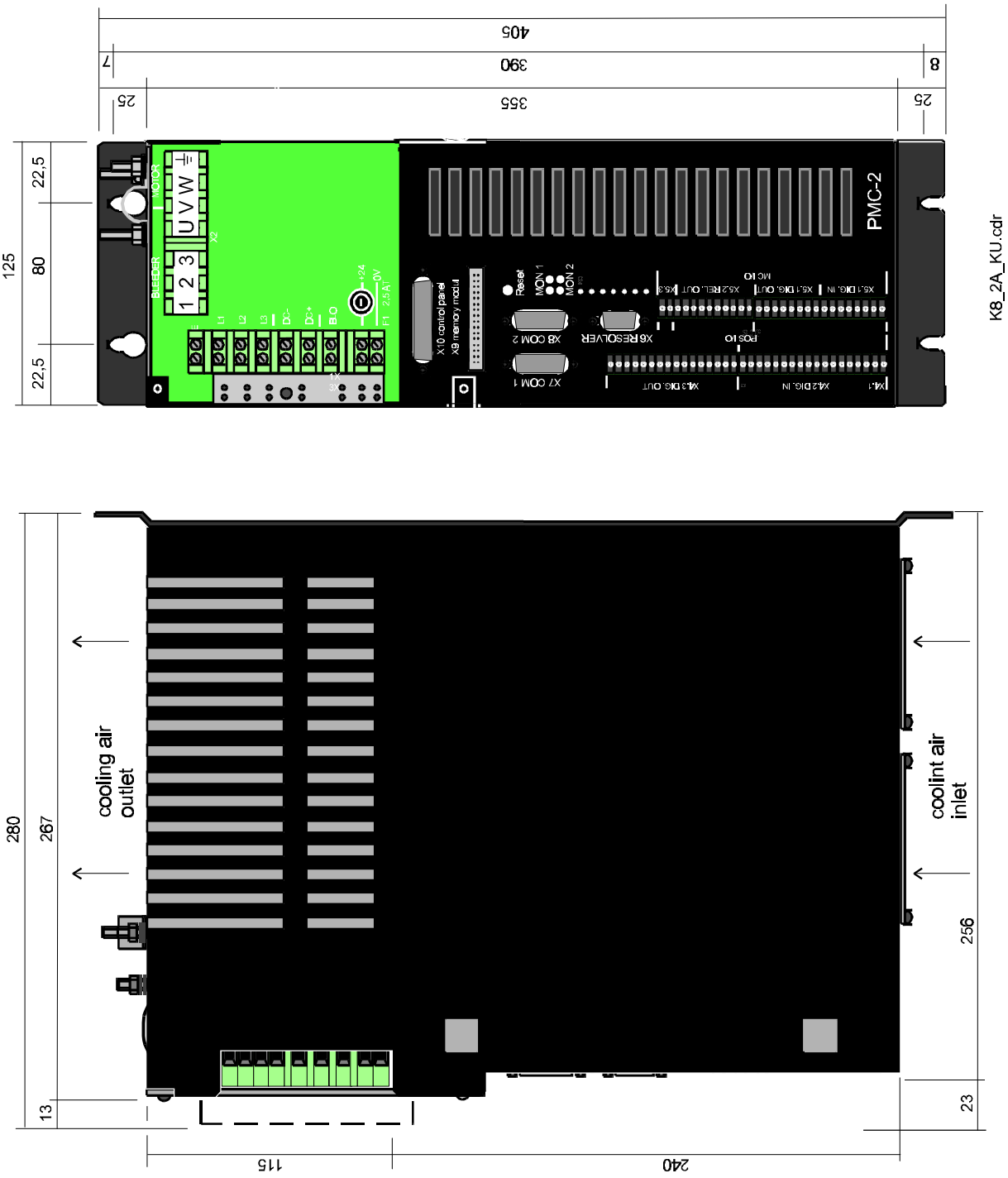


PMC-2/5A and 8A Long Form



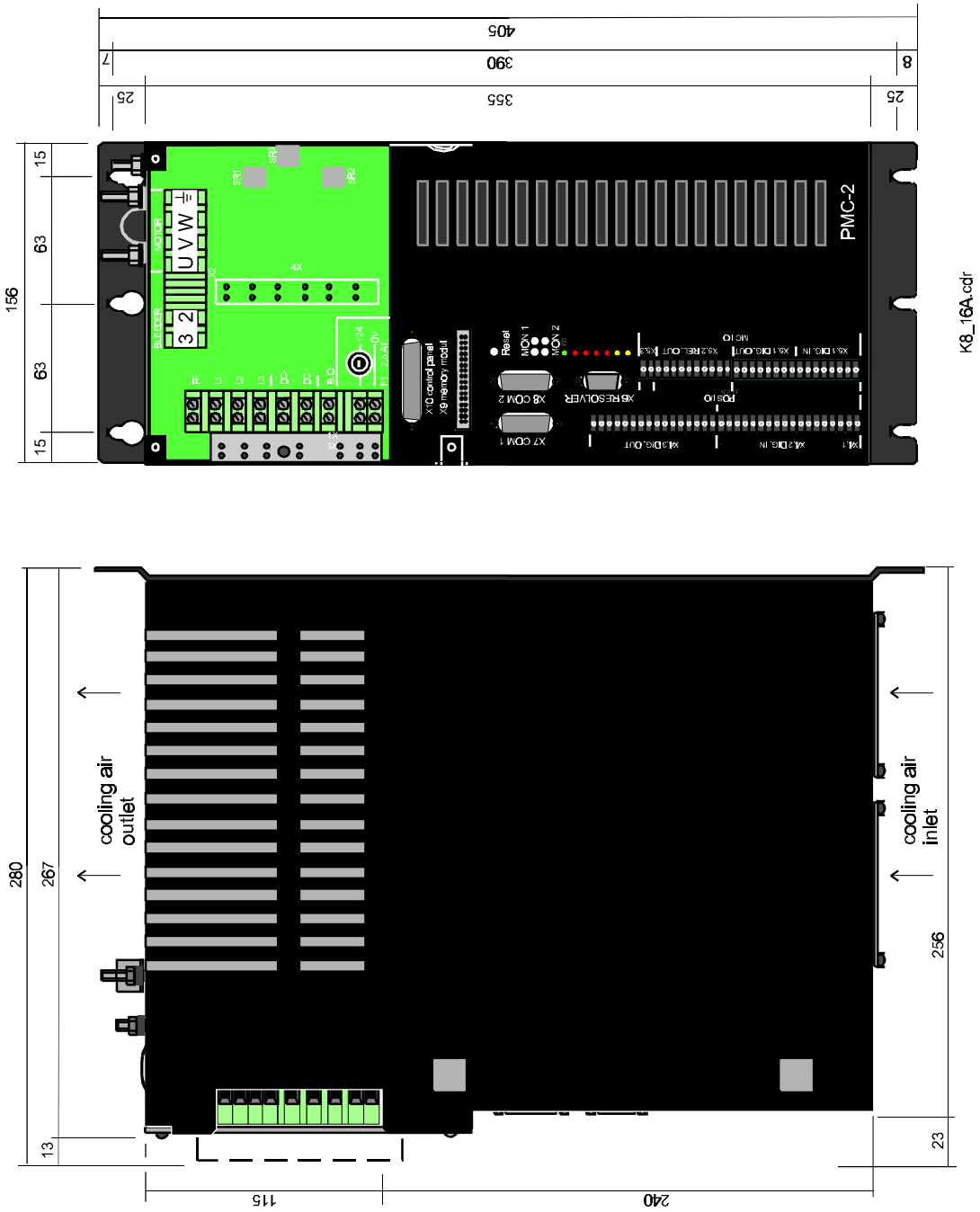


PMC-2/5A and 8A Short Form



PMC-2/16A and 25A Short Form without Bleeder

CAUTION	An external bleeder is absolutely necessary to operate this PMC-2 base unit.



5.1.2 Technical Data

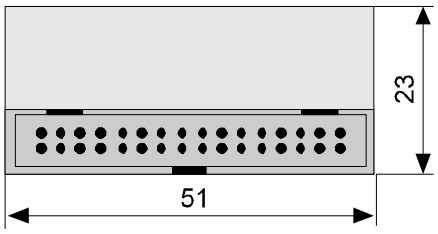
	PMC-2/4	PMC-2/5	PMC-2/8	PMC-2/16	PMC-2/25
Mains input					
Rated AC voltage	3 x 360 ... 460V (400V -10%/+15%)				
Mains frequency	48 ... 62 Hz				
24V Control Voltage	22 ... 33V DC/2A (logic supply)				
Standard inputs					
Input voltage/current	20 ... 33V DC/5mA				
Input filter standard	5ms				
Input filter interrupt inputs	0.1ms				
Motor protector	PTC or switch				
Resolver	2-pole resolver				
Standard outputs					
Digital outputs	20 ... 33V DC/0.1A				
Relay outputs	60V DC/0.2A				
2 Monitor outputs					
• Use	regulator adjustment, commissioning and diagnosis				
• Output voltage	± 10V				
• Output current	max. 3mA				
• Tolerance	± 2%				
• Resolution	12 bit				
• Updating time	1.3ms				
• System variables	MON1 -> S3.08 MON2 -> S3.09				
Communication					
Standard	2 RS 232/485 with SINEC L1				
Option	field bus interface via option module				
Plug-in optional modules					
maximum number	4 modules				
X11	FLB-1				
X12 encoder	SCI-1, IKA-1 or INC-1				
X13 Communication	IBS-2, DPS-1				
X14 Analogue I/O	ANA-1				
Conditions for use					
Surrounding temperature at rated data	+5°C to +45°C				
Storage temperature	-20°C to +70°C				
Air humidity	class F according to DIN 40040				
Protection means	IP20				

	PMC-2/4	PMC-2/5	PMC-2/8	PMC-2/16	PMC-2/25
Motor controller					
Rated current (effective value) Inc	4A	5A	8A	16A	25A
Peak current (effective value for 1 sec) Isc	8A	10A	16A	32A	50A
Rated power	2.8kVA	3.4kVA	5.5kVA	11kVA	17kVA
DC-circuit capacity	235µF	235µF	470µF	940µF	940µF
Tact frequency	12kHz				
Revolution	0 ... ± 6000 rpm				
Short-circuit proof	yes				
Earthing proof	yes				
Overload proof	yes				
DC-circuit voltage	510 ... 650V DC (735 V DC)				
Connection ext. bleeder	available				
$U_{bleeder}$ ON	approx. 735V				
$U_{bleeder}$ OFF	approx. 700V				
Resistance $_{bleeder}$	47Ω	47Ω	27Ω	external only	external only
Permanent power $_{bleeder}$	250W	250W	250W	Bl. ≥ 13.5Ω	Bl. ≥ 10Ω
Peak power $_{bleeder}$	5kW	5kW	8kW	16kW	22kW
Stray power at rated current (incl. mains connector, excl. stray bleeder power)	110W	130W	180W	310W	480W
Fuse F1 (control voltage)	2.5 A T	2.5 A T	2.5 A T	2.5 A T	2.5 A T
Weight	approx. 6.5kg	approx. 8.0kg	approx. 8.0kg	approx. 12.5kg	approx. 12.5kg

Memory Module MM15

The MM15 serves as an external data storage for the PMC-2.

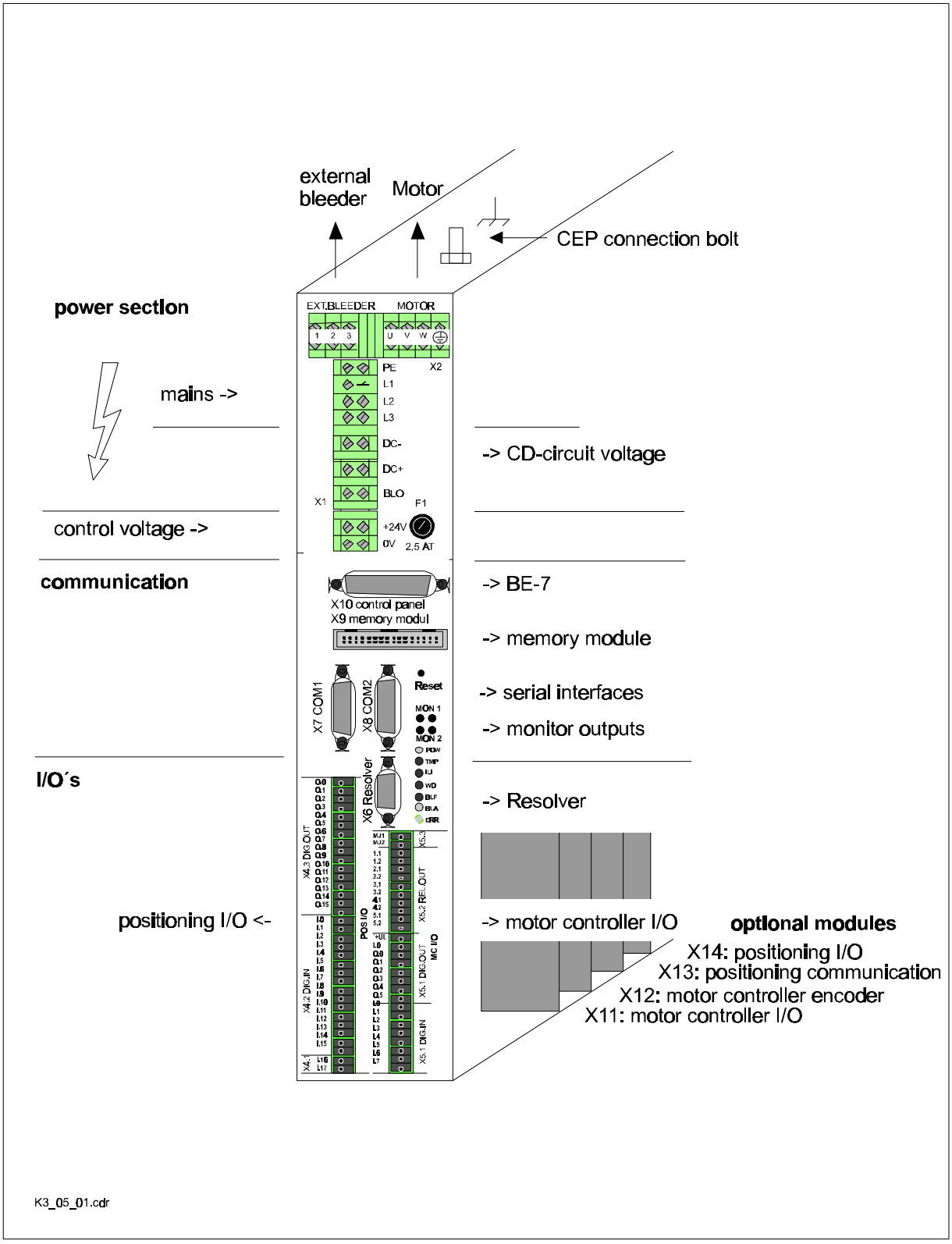
Type	128kB flash EPROM, plugged externally
Connector plug	34-pole connector plug



K8_MM15.cdr

CAUTION	The MM15 may be exchanged only if the PMC-2 is switched current-free (24V control voltage off)!

5.1.3 Electrical Connections



5.1.3.1 X1 and X2 Power Components

Connector	Pin	Meaning
X1 	PE	Mains connection
	L1	Mains connection
	L2	Mains connection
	L3	Mains connection
	DC -	DC-circuit (output voltage 510 – 735 V DC)
	DC +	DC-circuit (output voltage 510 – 735 V DC)
	BLO	”Bleeder On” control signal for bridging DC-circuits
	+24V	Control voltage (I_max. = 2A) (input)
	0V	Control voltage (input)

CAUTION	The DC-circuit must not be earthed.

Note:
The 0 Volt control voltage (X1 / 0V) can be earthed.

Connector	Pin	Meaning	SB Motor
X2	1	<- internal bleeder In	
	2	-> bleeder Out	
	3	<- external bleeder In	
	U	Motor	A motor connection
	V	Motor	B motor connection
	W	Motor	C motor connection
	⏚	Motor earth conductor connection	D motor connection

Note:

Internal bleeder bridge X2 pin 1 and pin 2 (factory-set status)
External bleeder connect X2 external bleeder resistor to pin 2 and pin 3

- Devices without pin 1 have no internal bleeder.
- The bleeder cable must be shielded if it is longer than 1 metre, otherwise it must be twisted.

Connector plug X2:
Conntect the shield of the motor cable at the side of the motor on the connector casing and at the side of the PMC-2 on the strain relief clamp, which at the same time serves as a shield connector. The strain relief clamp is located on the top of the PMC-2. The motor cable must be completely shielded.

5.1.3.2 X4 Inputs and Outputs of the Positioning Level

Connector	Pin	Meaning	Variable	Factory-set Status
X4.3	O.0	Outputs	O0.0	Automatic mode
	O.1		O0.1	Manual mode
	O.2		O0.2	Ready for operation
	O.3		O0.3	Disturbance
	O.4		O0.4	Warning
	O.5		O0.5	TP1 active
	O.6		O0.6	Homed
	O.7		O0.7	Homing active
	O.8		O0.8	
	O.9		O0.9	
	O.10		O0.10	
	O.11		O0.11	
	O.12		O0.12	
	O.13		O0.13	
	O.14		O0.14	
	O.15		O0.15	
X4.2	I.0	Inputs	I0.0	Automatic mode
	I.1		I0.1	Manual mode
	I.2		I0.2	T1
	I.3		I0.3	Quick stop
	I.4		I0.4	Error acknoledgement
	I.5		I0.5	Start / manual drive positive
	I.6		I0.6	Single-step / manual drive negative
	I.7		I0.7	Homing
	I.8		I0.8	Quick motion/creep speed for manual mode
	I.9		I0.9	
	I.10		I0.10	
	I.11		I0.11	
	I.12		I0.12	
	I.13		I0.13	
	I.14		I0.14	
	I.15		I0.15	
X4.1	I.16	Interrupt In IRQ 1	S0.18	Fixed assignment
	I.17	Interrupt In IRQ 2	S0.19	Fixed assignment

Note:
The factory-set status can be changed in the parameters.
(see Parameters P5.00)

5.1.3.3 X5 Inputs and Outputs of the Motor Controller

Connector	Pin	Meaning	Variable
X5.3	Mϑ1	Connection motor temperature switch or PTC	S0.16
	Mϑ2		
X5.2	1.1	O_disturbance (normally closed contact)	S1.03
	1.2		
	2.1	O_warning (normally closed contact)	S1.04
	2.2		
	3.1	O_brake (normally open contact)	S0.06
	3.2		
	4.1	O_mains contactor (normally open contact)	S0.07
	4.2		
	5.1	O_DC_short circuit (normally open contact)	S0.08
	5.2		
X5.1	+UL	+ 24V	Voltage supply in I/O level and motor temperature control logic
	L0	L0	
	O.0	Output drive is moving	S0.00
	O.1	Output within target window	S0.01
	O.2	Output free	
	O.3	Output free	
	O.4	Output motor temperature too high	S0.16
	O.5	Output T1_operation active	S0.09
	I.0	Input enable	S0.10
	I.1	Input emergency stop (LOW active)	S0.17
	I.2	Input free	
	I.3	Input homing switch	S0.13
	I.4	Input positive limit switch	S0.14
	I.5	Input negative limit switch	S0.15
	I.6	Input touchprobe_1	S0.11
	I.7	Input touchprobe_2	S0.12

Note:

The relay outputs X5.2 may be stressed with a maximum of 200mA and 60V.

The relay outputs X5.2 have a contact protection against overload (PTC in series with the respective contact).

The 0 Volt (L0) of the I/O level (connector X5.1 / L0) can be earthed.

Galvanic Separation:
All inputs and outputs of the positioning level and the motor controller are internally guided by opto-coupler. For optimal use of this galvanic separation, a separate mains contactor must be used for the 24 Volt control voltage (connector X1). The 0V must not be earthed.

5.1.3.4 X6 Resolver

Connector	Pin	Meaning	SB Motor
X6	1	free	
D-sub	2	free	
outlet	3	SIN -	E resolver connection
	4	COS -	C resolver connection
	5	EXCT -	B resolver connection
	6	free	
	7	SIN +	F resolver connection
	8	COS +	D resolver connection
	9	EXCT +	A resolver connection

Note:
The shield is laid on the connector plug casing on both sides.

5.1.3.5 X7 COM1 and X8 COM2

The serial interfaces are needed for programming, parameter setting, diagnosis, commissioning and operation.
They can be operated optionally as RS 232 or RS 485.

Connector	Pin	Meaning	
X7 / X8	1	free	
D-sub	2	TxD	RS 232
outlet	3	RxD	RS 232
	4	>	RS 232 out
	5	<	COM in
	6	>	RS 485 out
	7	GND	RS 232
	8	TxD -	RS 485
	9	TxD +	RS 485
	10	RxD -	RS 485
	11	RxD +	RS 485
	12	GND	RS 485
	13	free	
	14	GND	
	15	+ 5V	

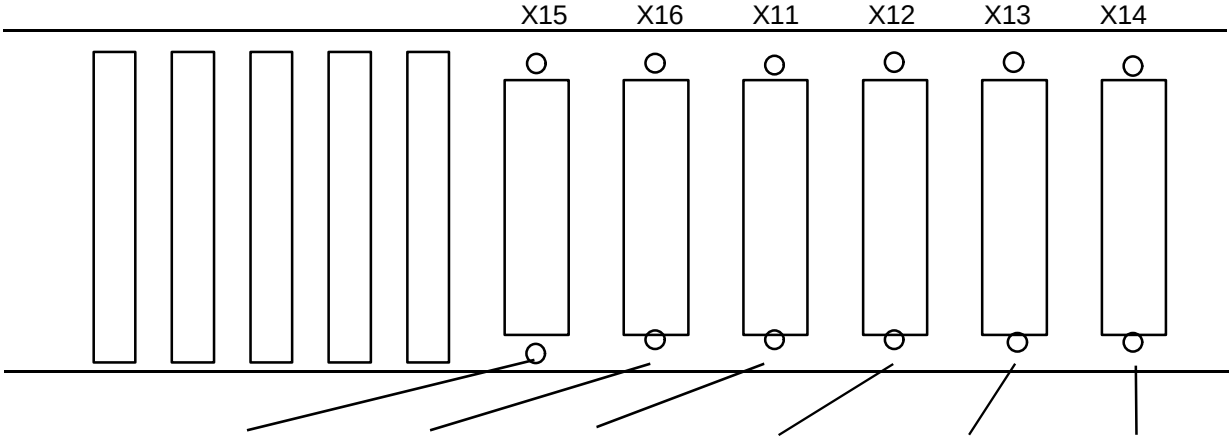
RS 232 interface (bridge in the respective cable from pin 5 to pin 4)
- Only one drive at a time can be operated with EPAS-3 via RS 232 interface.
- maximum transmission length 10 metres

RS 485 interface (bridge in the respective cable from pin 5 to pin 6)
- Realisation of a serial bus with up to 32 units
- Maximum transmission length 100 metres
- Commissioning of several PMC-2 with EPAS-3 without replugging the interface cable

Note:
The shield is connected unilaterally to the PMC-2 via the connector plug casing.

5.1.4 Optional Modules

Occupation of sockets for optional modules: (-> see also S9.12 - S9.15)



Connector	X15	X16 Encoder 2	X11	X12 Encoder	X13 Communication	X14 Analogue I/O
ANA-1						DSUB 15-pole pin
IBS-2	DSUB 9-pole socket (outgoing interface)				DSUB 9-pole pin (incoming interface)	if FLB-1 and IBS-2 then outgoing interface here
DPS-1					DSUB 9-pole socket	
FLB-1	DSUB 9-pole socket (outgoing interface)		DSUB 9-pole socket (incoming interface)			
IKA-1		DSUB 15-pole socket INK encoder 2	DSUB 9-pole pin analogue input	DSUB 9-pole socket encoder simulation		
SCI-1		DSUB 15-pole pin SinCos 2 or DSUB 15-pole socket INK encoder 2		DSUB 15-pole pin SinCos 1		

5.1.4.1 SinCos Module (SCI-1)

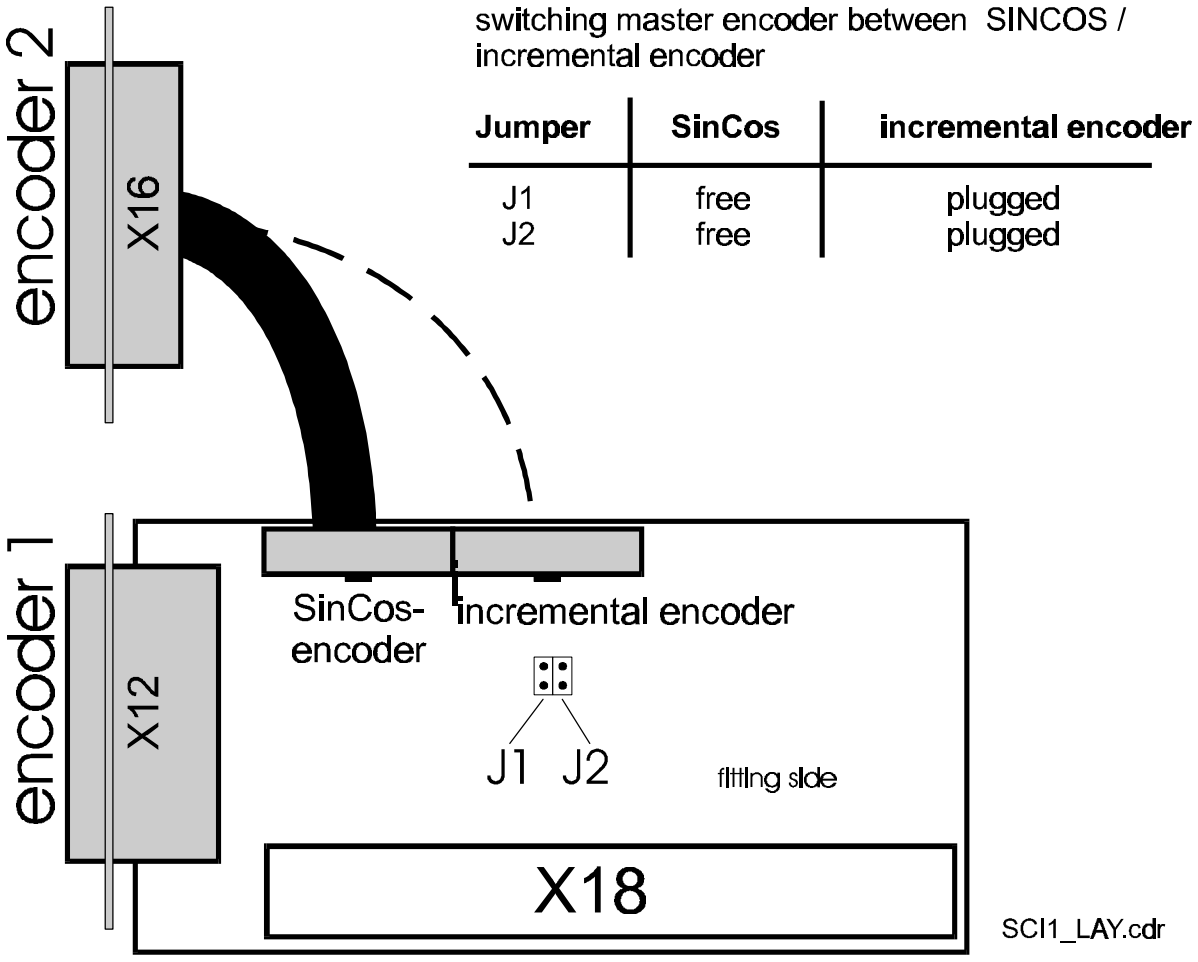
By means of the optional module SCI-1, the PMC-2 can read in high-resolution revolution encoders (SinCos encoders). Moreover, the SCI-1 has an incremental encoder input. Two SinCos encoders or one SinCos and one incremental encoder can be connected.

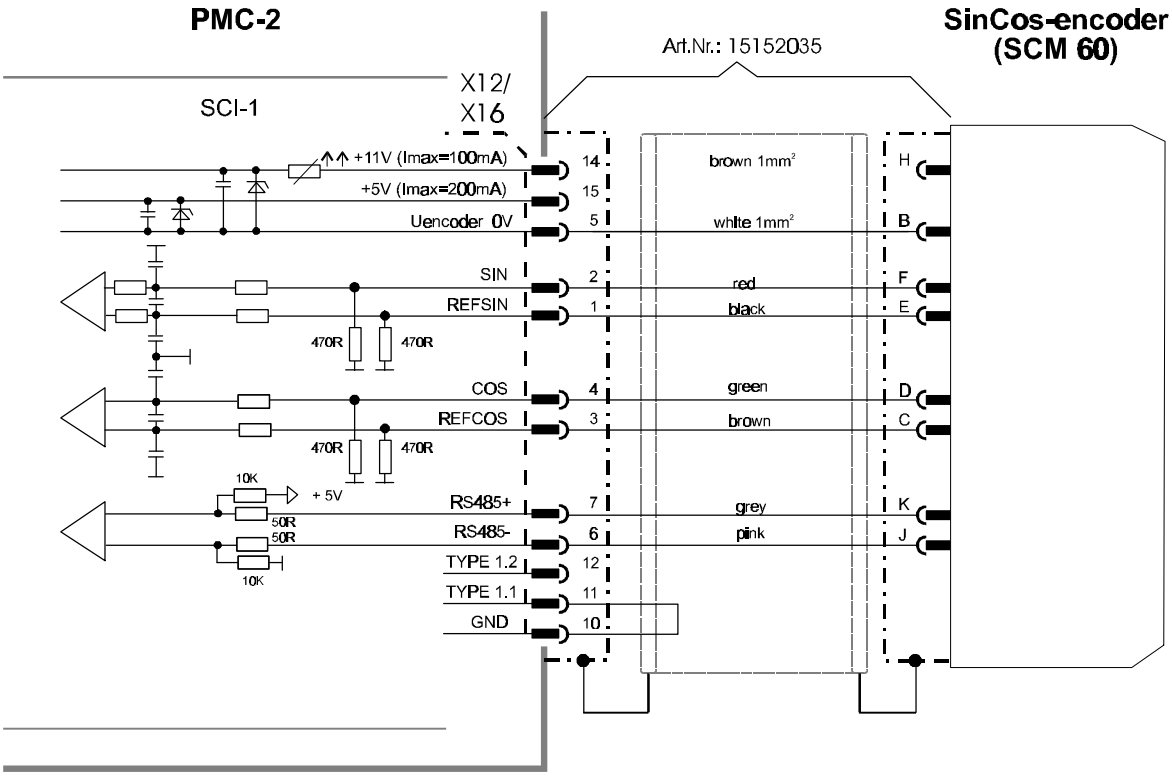
SinCos encoder inputs

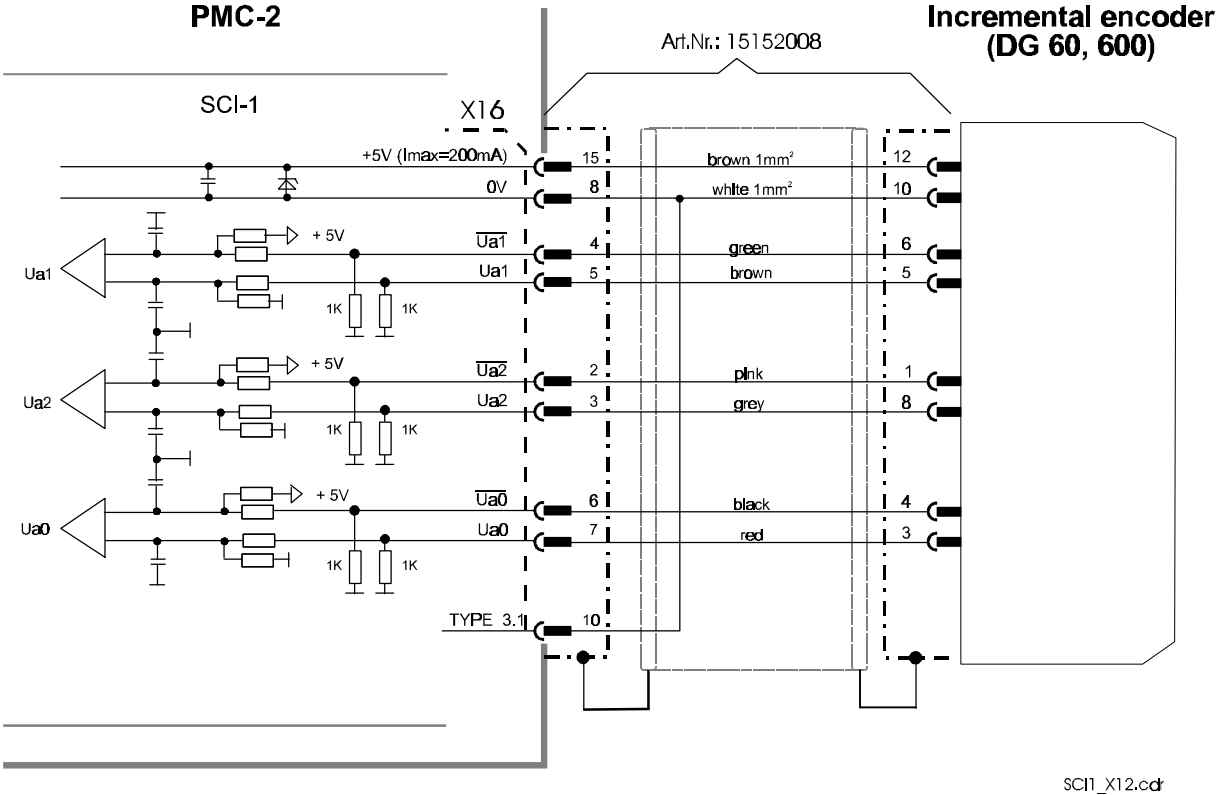
Connector (X12/X16)	15-pole D-Sub pin
Encoder supply Voltage Current	 +11V DC max. 100mA per encoder
Analogue tracks **Parameter channel**	 differential inputs (Sin, RefSin / Cos, RefCos) max. input level 1.1 Vss max. input frequency 200kHz asynchronous, bi-directional RS485 interface

Incremental Encoder Input

Connector (X16)	15-pole D-Sub socket
Overload protection	no short-circuit protection
Signal tracks	level according to RS 422, for incremental encoders with rectangular signals
Input frequency	max. 250kHz
Pulse multiplication	4




PMC-2
SCI-1
X12/
X16
Art.Nr.: 15152035
SinCos-encoder
(SCM 60)
+11V (Imax=100mA)
+5V (Imax=200mA)
Uencoder 0V
SIN
REFSIN
COS
REFCOS
RS485+
RS485-
TYPE 1.2
TYPE 1.1
GND
470R
10K
50R
+ 5V
14
15
5
2
1
4
3
7
6
12
11
10
brown 1mm²
white 1mm²
red
black
green
brown
grey
pink
H
B
F
E
D
C
K
J


PMC-2
SCI-1
X16
Art.Nr.: 15152008
Incremental encoder
(DG 60, 600)
+5V (Imax=200mA)
0V
Ua1
Ua2
Ua0
TYPE 3.1
+ 5V
1K
15
8
4
5
2
3
6
7
10
12
10
6
5
1
8
4
3
brown 1mm²
white 1mm²
green
brown
pink
grey
black
red

SCI1_X12.cdr

5.1.4.2 Incremental Encoder Simulation Module (IKA-1)

The purpose of this option module is to convert the position values received from the resolver into incremental encoder signals and pass them on to further positioning controls (e.g. SX-2, PMC-2). Moreover, the module has an analogue set value input by which also voltages (-10 ... +10V) or currents (0 ... 20mA) can be read in. In addition, an incremental encoder input was realised.

Encoder simulation output

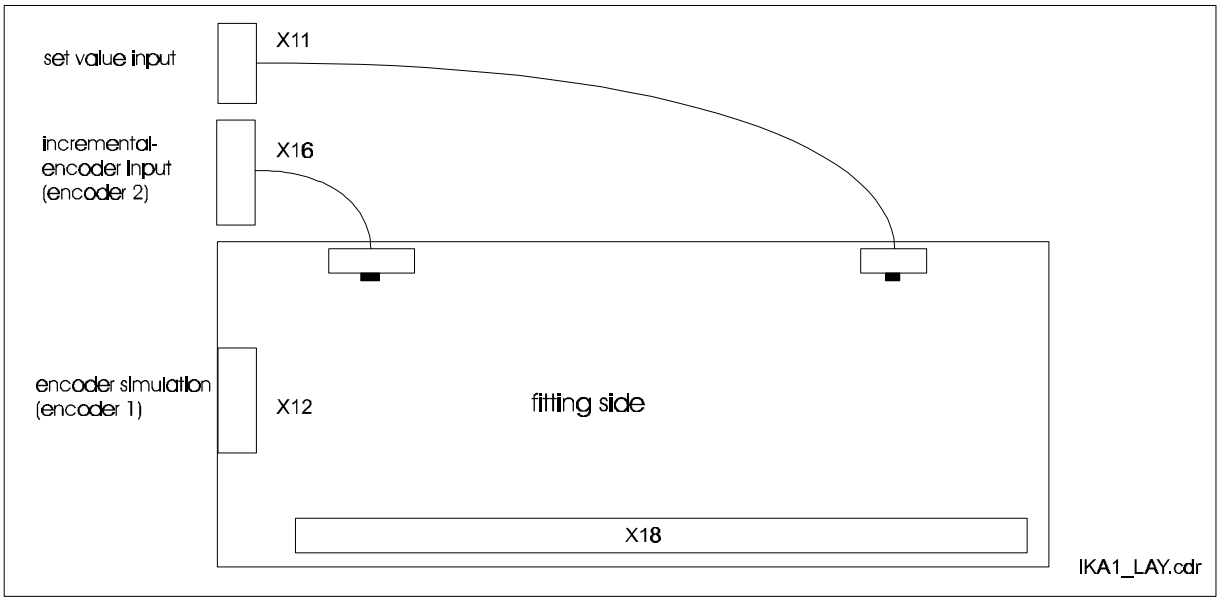
Connector (X12)	9-pole D-Sub socket
Signal tracks	level according to RS 422, for incremental encoder with rectangular signals
input frequency	max. input frequency 250kHz
Increments / revolution	2048 Incr/revolution (encoder 1)

Analogue input

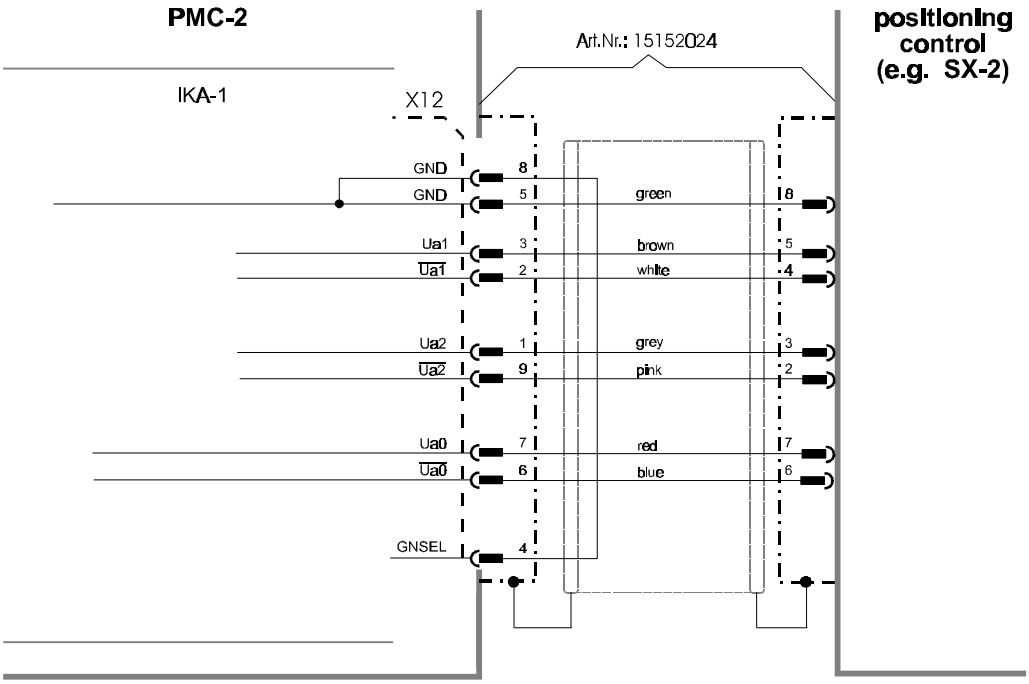
Connector (X11)	9-pole D-Sub pin
Analogue input for input voltage for input current	 -10V ... +10V 0 ... 20mA
Reference voltage	+15V / -15V

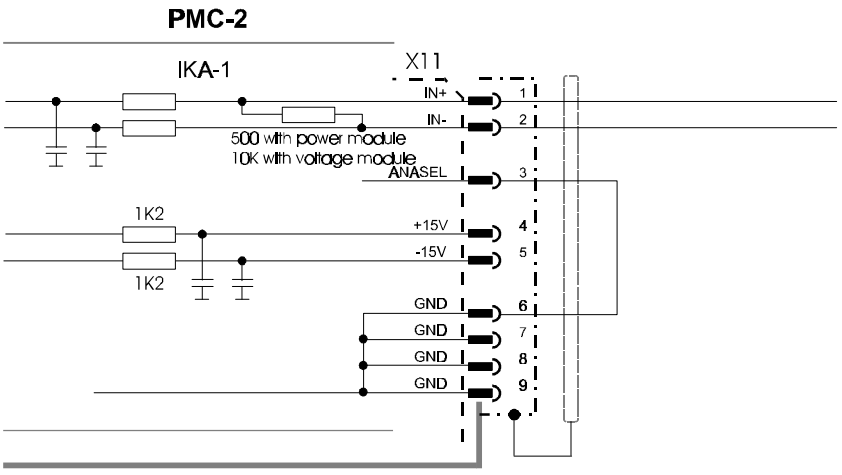
Incremental encoder input (optional)

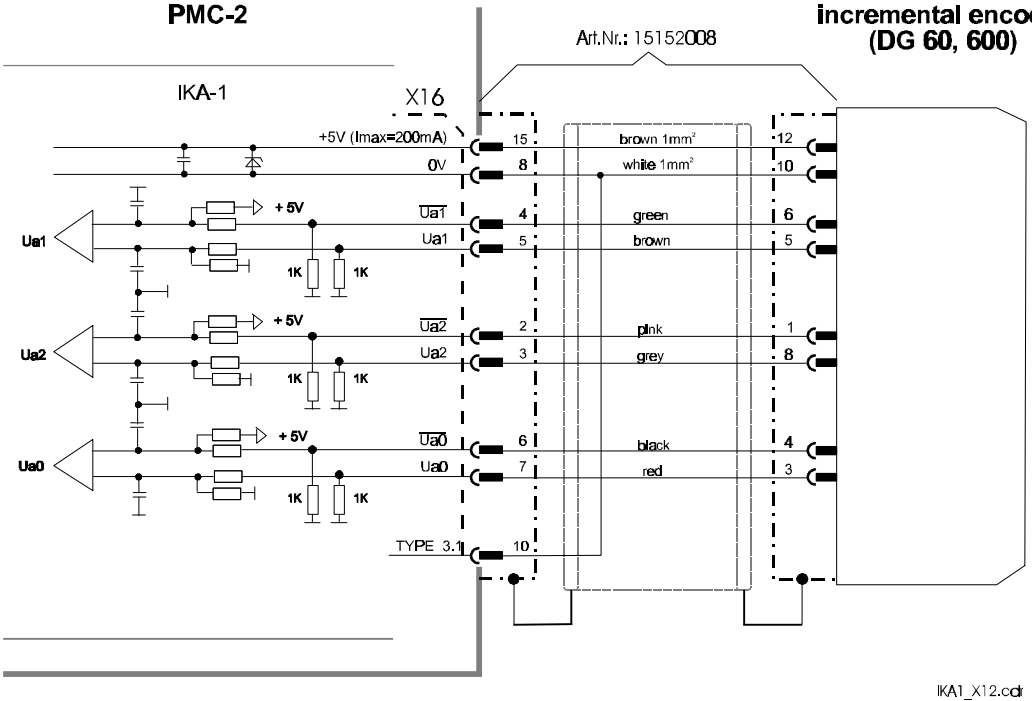
Connector (X16)	15-pole D-Sub socket
Overload protection	no short circuit protection
Signal tracks	level according to RS 422, for incremental encoder with rectangular signals
Input frequency	max. 250kHz
Impulse multiplication	4



CAUTION	To ensure the correct functioning of the encoder simulation, ”Resolution_Enc_1” (P3.02) must be equal to ”Resolution_Enc_0” (P3.00).

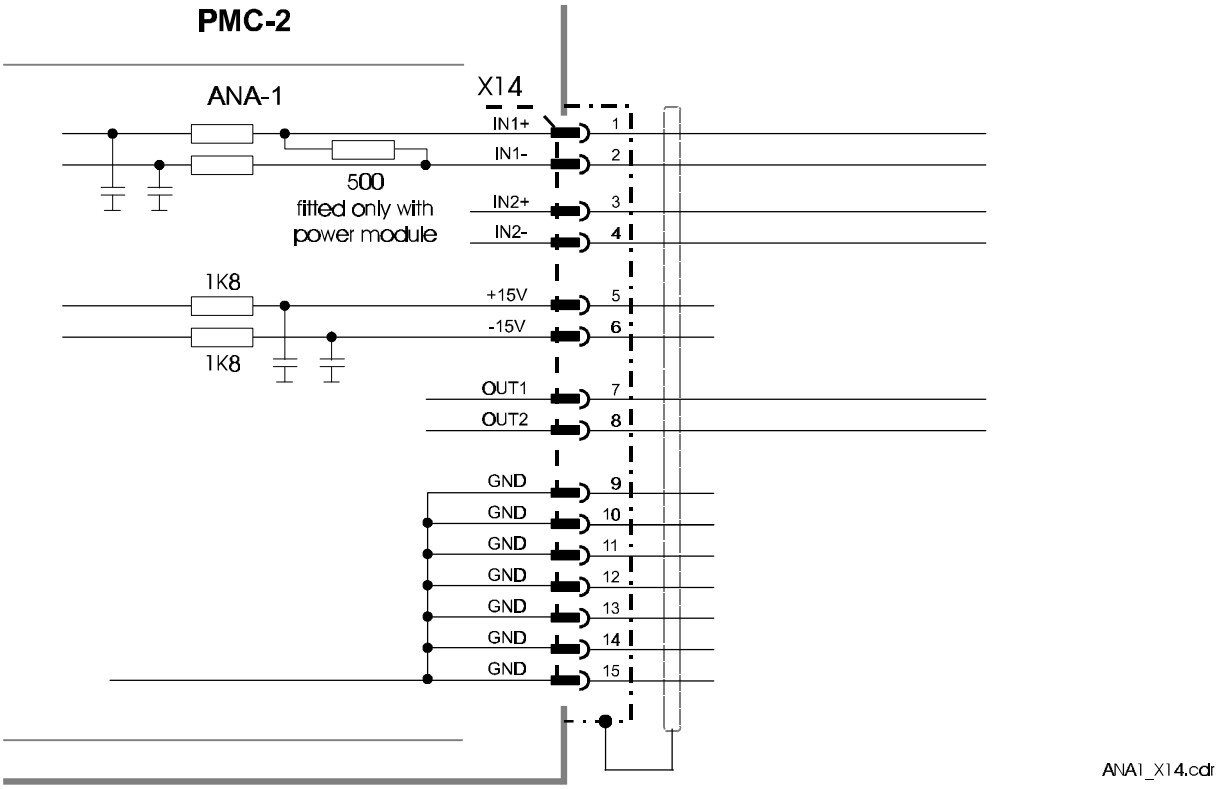

PMC-2
IKA-1
X12
Art.Nr.: 15152024
positioning control (e.g. SX-2)
GND 8
GND 5
green 8
Ua1 3
brown 5
Ua1 2
white 4
Ua2 1
grey 3
Ua2 9
pink 2
Ua0 7
red 7
Ua0 6
blue 6
GNSEL 4


PMC-2
IKA-1
X11
IN+ 1
IN- 2
500 with power module
10K with voltage module
ANASEL 3
1K2
1K2
+15V 4
-15V 5
GND 6
GND 7
GND 8
GND 9


PMC-2
IKA-1
X16
Art.Nr.: 15152008
incremental encoder (DG 60, 600)
+5V (Imax=200mA) 15
brown 1mm² 12
0V 8
white 1mm² 10
+ 5V
Ua1
Ua1 4
green 6
Ua1 5
brown 5
1K 1K
+ 5V
Ua2
Ua2 2
pink 1
Ua2 3
grey 8
1K 1K
+ 5V
Ua0
Ua0 6
black 4
Ua0 7
red 3
1K 1K
TYPE 3.1 10
IKA1_X12.cdr

5.1.4.3 Analogue I/O Modules (ANA-1)

Connector (X14)	15-pole D-Sub pin
Analogue inputs for input voltage for input current	 -10V ... +10V 0 ... 20mA
Analogue outputs for output voltage max. output current	 -10V ... +10V 10mA
Homing voltage	+15V / -15V



5.1.4.4 Communication Module INTERBUS-S (IBS-2)

The optional modules IBS-2 are for coupling the positioning motor controller PMC-2 to the INTERBUS-S field bus.

Incoming Interface

Connector	Pin	Meaning
X13 D-Sub connector	1	DO1
	2	DI1
	3	GND
	4	free
	5	free
	6	DO1
	7	DI1
	8	free
	9	free

Outgoing Interface

Connector	Pin	Meaning
X15 (X14) D-Sub outlet	1	DO2
	2	DI2
	3	GND
	4	free
	5	VCC
	6	DO2
	7	DI2
	8	free
	9	RBST

Note:

- If the outgoing interface is used, the connector must have a bridge from PIN 9 to PIN 5 in order to open the loop to the next element.
- The shield is connected on both sides.
- The PMC-2 does not support PCP services.
- SUPI 3 is used on the optional moduleIBS-2.

For more detailed description, see PMC-2 manual, chapter 9.3 and Interbus-S documentation by Phoenix Contact.

CAUTION	VCC is not short-circuit proof!

5.1.4.5 Communication Module PROFIBUS-DP Slave (DPS-1)

The DPS-1 is for coupling the positioning motor controller PMC-2 to the PROFIBUS-DP.

Connector	Pin	Meaning
X13 D-Sub outlet	1	shield
	2	free
	3	B-line
	4	RTS
	5	GNDEXT
	6	VCCEXT
	7	free
	8	A-line
	9	free

Note:
- The limit resistor integrated in the bus connector must be switched active at the first and last unit.
- The shield is fixed on both ends.

5.1.4.6 Fast Local Bus Module (FLB-1)

Incoming Interface

Connector	Pin	Meaning
X11 D-Sub outlet	1	VSDAT-
	2	VSDAT+
	3	VSCLK+
	4	SYNCH+
	5	SYNCH-
	6	free
	7	VSCLK-
	8	GNDEXT
	9	VCCEXT

Outgoing Interface

Connector	Pin	Meaning
X15 D-Sub outlet	1	VSDAT-
	2	VSDAT+
	3	VSCLK+
	4	SYNCH+
	5	SYNCH-
	6	free
	7	VSCLK-
	8	GNDEXT
	9	VCCEXT

Notes:
- The shield is fixed on both ends.
- The two interfaces are identical and can therefore be exchanged.
- A limit resistor BT-3 must be used at the first and last participant.
- A maximum of 32 units can be connected to the BUS (1 master and 31 slaves).
- The maximum length of the complete bus is 100 metres.

5.2 Motors

5.2.1 Structures

5.2.1.1 Motor Series

The following motor lines are available:

SB-056
SB-070
SB-105
SB-145
SB-205

SB is short for servo motor brushless; the numbers represent the flange dimensions.

There are several torque graduations for each line; plus each torque size is available with different rated speeds.

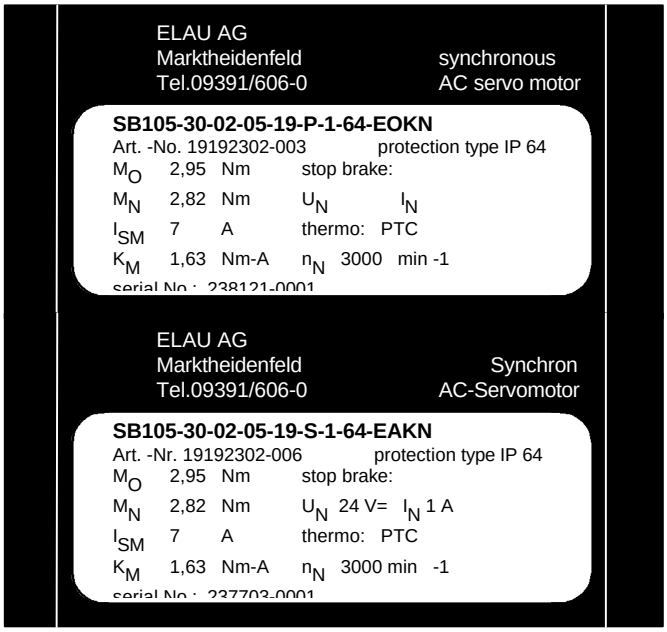
The torque graduations in Nm:

SB-056	0,6			
SB-070	1	2		
SB-105	2	4	6	8
SB-145	8	15	22	28
SB-205	27	50		

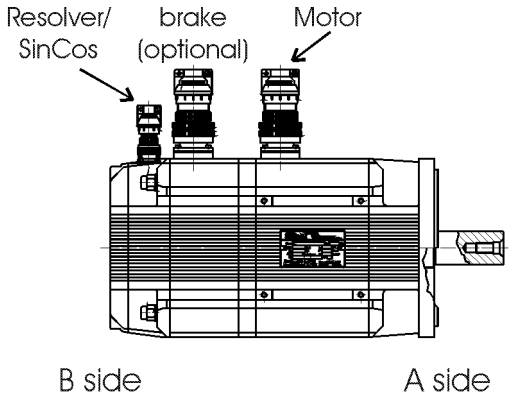
Speed graduations in rpm:

SB-056	5000	
SB-070	4000	
SB-105	3000	
SB-145	3000	
SB-205	2000	3000

All essential motor data are included in the motor type label.



5.2.1.2 Motor Connector Plug



Motor

Connector	Pin	Meaning	PMC-2
MIL	A	U	X2 U
pin	B	V	X2 V
	C	W	X2 W
	D	earth conductor	X2 earth conductor
	E	Mϑ1 temperature contact	X5.3 Mϑ1
	F	Mϑ2 temperature contact	X5.3 Mϑ2
	G	free	
	Connector casing	cable shielding	strain relief clamp

Resolver or SINCOS

Connector	Pin	Meaning (Resolver)	PMC-2
MIL	A	EXCT +	X6 9
pin	B	EXCT -	X6 5
	C	COS -	X6 4
	D	COS +	X6 8
	E	SIN -	X6 3
	F	SIN +	X6 7
	G	cable shielding	X6 Connector casing
	H	free	
	J	free	
	K	free	

Connector	Pin	Meaning (SINCOS)	PMC-2
MIL	A	free	
pin	B	0V encoder	X12 5
	C	REFCOS	X12 3
	D	COS	X12 4
	E	REFSIN	X12 1
	F	SIN	X12 2
	G	free	
	H	11V encoder	X12 14
	J	- RS485	X12 6
	K	+ RS485	X12 7
	Connector casing	cable shielding	X12 Connector casing

Brake

Connector	Pin	Meaning	Switching cabinet
MIL	A	+ 24V DC	Brake contactor
pin	B	0V	L0
	C	free	
	Connector casing	cable shielding	PE

5.2.1.3 Motor Shaft and Bearing

Design of the Shaft End

Smooth shaft end (standard)

In case of a frictional connection, torque transmission must be achieved exclusively by surface pressure. This ensures a safe load transmission without play.

Manufacturer	Designation	Remarks
KTR Kupplungstechnik GmbH Rodder Damm 170 48432 Rheine	CLAMPEX clamp set	SB 056: KTR 250 - 11x18 SB 070: KTR 250 - 11x18
Spieth Maschinenelemente Alleenstraße 41 73730 Esslingen	Spieth pressure sleeve series DSM	SB 105: DSM 19.2 SB 145: DSM 24.2 SB 205: DSM 38.2

Table: Manufacturers of frictional connections

Shaft end with feather groove according to DIN 6885

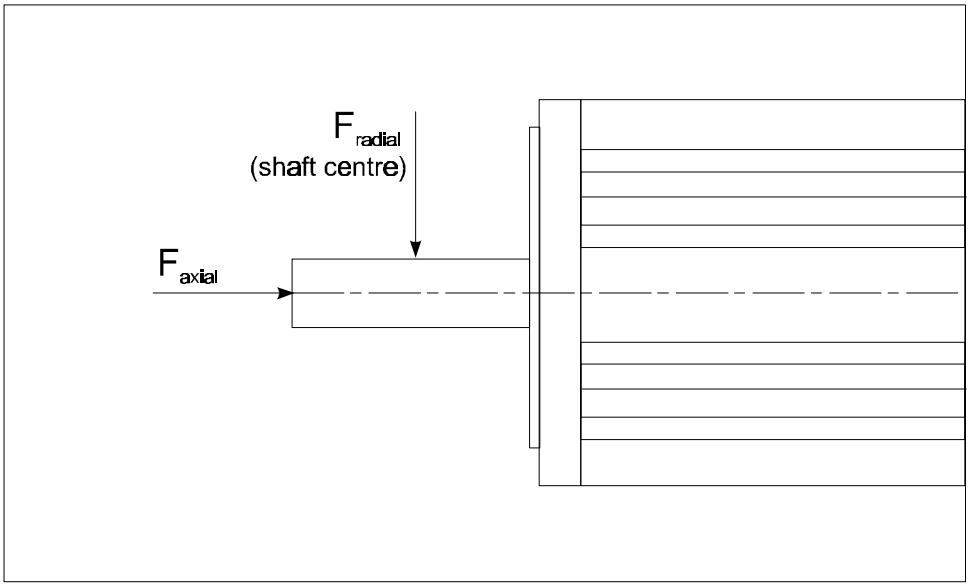
Shaft connections with feather are frictional. Under continuous duty with variable torque rates or high reversing activity, the position of the feather may deflect, so that concentricity is impaired (a play develops!). Increasing deformation may cause the feather to break and thus damage the shaft. For this reason, this kind of shaft-hub connection is suitable only for low strain. We recommend the use of smooth shaft ends.

Bearing

The bearing on the A side is a fixed bearing, on the B side a loose bearing. Therefore heat-related expansion of the runner has no effect on the A side.

Permissible shaft stress

Definition:



Permissible radial force F_{radial} [N]

Motor	1000 1/min	2000 1/min	3000 1/min	4000 1/min	5000 1/min	6000 1/min
SB 056xx06	388	318	274	249	231	
SB 070xx05	527	431	372	337	312	295
SB 070xx10	546	447	398	360	324	306
SB 070xx15	589	482	416	376	350	330
SB 070xx20	607	497	428	388	360	340
SB 105xx02	927	755	652	590		
SB 105xx04	1000	820	710	643		
SB 105xx06	1061	866	750	679		
SB 105xx08	1100	896	775	701		
SB 145xx08	1335	1095	940	851		
SB 145xx15	1445	1185	1020	923		
SB 145xx22	1515	1240	1070	968		
SB 145xx28	1560	1280	1100	996		
SB 205xx27	3435	2850	2430			
SB 205xx50	3750	3070	2650			
SB 205xx70	3950	3235	2790			
SB 205xx90	4100	3350	2890			

Basis for calculation:
20,000 hours of operation as rated bearing life L_{10h} for a shaft without feather

permissible axial force F_{axial} [N]

$$F_{axial} = 0.2 * F_{radial}$$

5.2.1.4 Stop Brake

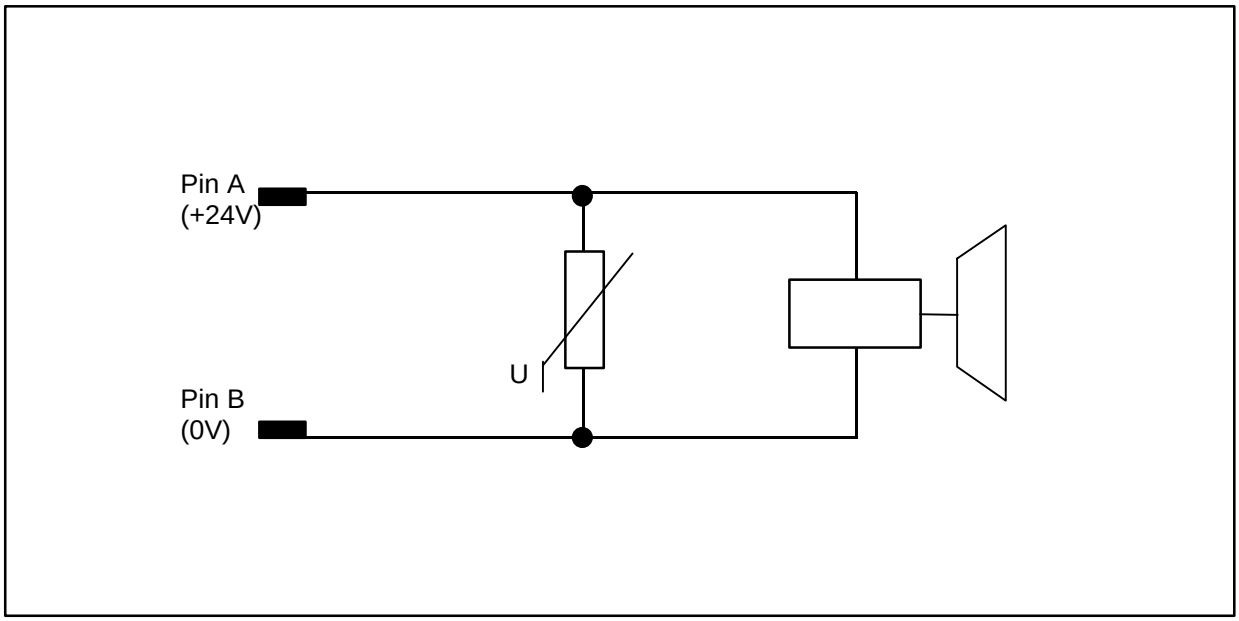
To hold the axle without play in standstill or current-free state, the servo motors can be supplied with a stop brake. The stop brake works according to the principle of zero signal current and is therefore a safety brake. In current-free state a spring force is exercised on the armature disc of the brake, i.e., the brake is closed and holds the axle. When applying 24V DC, the spring force is lifted and the brake opened.

CAUTION	The stop brake is not suitable as a working brake.

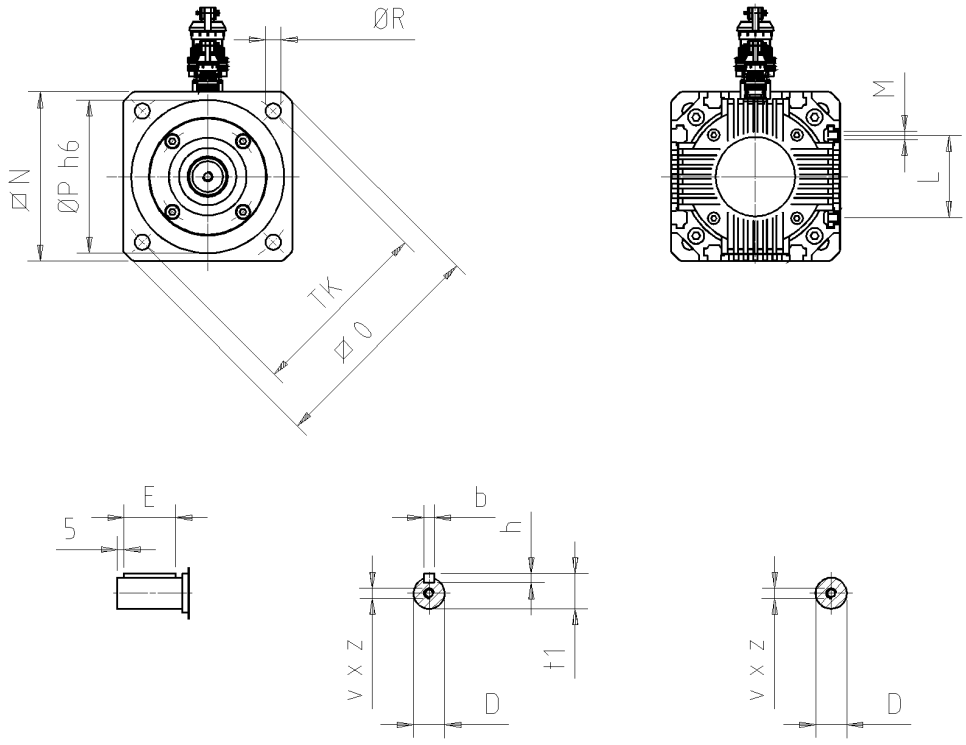
The stop brake is designed differently for each series:

	SB 056	**SB 070**	**SB 105**	**SB 145**	**SB 205**	
Moment of stop	0.8	1.5	5	15	50	[Nm]
Mass	0.8	2	3	5	14	[kg]
Moment of inertia	0.17	0.4	0.63	1.95	10	[kgcm^2]
Voltage	24 ±10%	24 ±10%	24 ±10%	24 ±10%	24 ±10%	[V] DC
Current intake	0.4	0.6	1.1	1.9	1.7	[A]

Connection diagram for the brake:

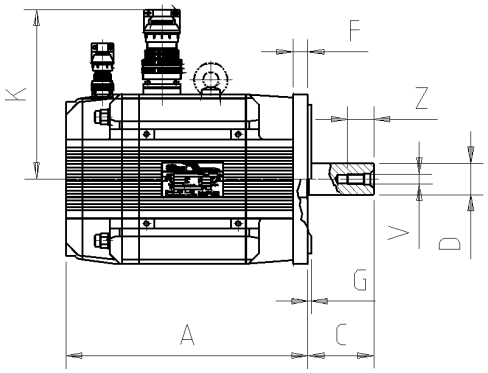


5.2.2 Mechanical Data of the Motor

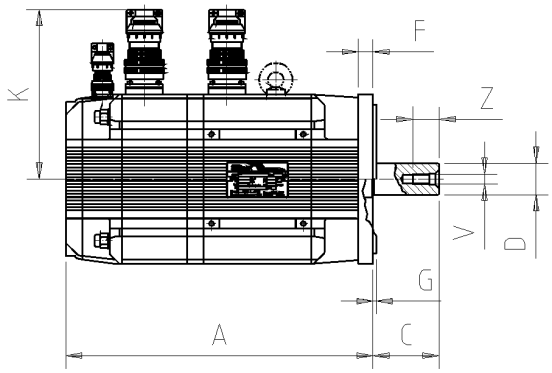


motor feedback: resolver

without brake

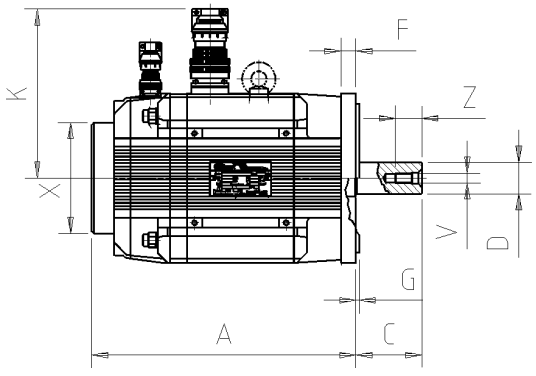


with brake

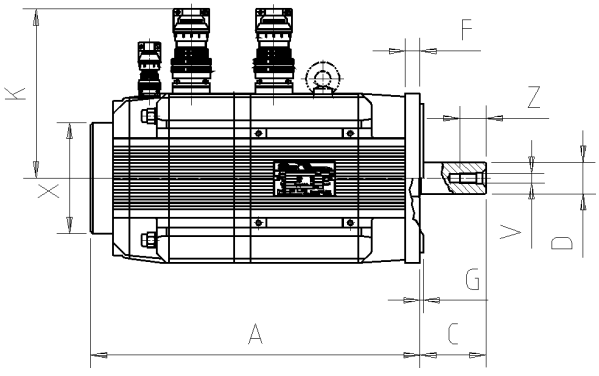


motor feedback: SinCos

without brake



with brake



Motor Feedback: Resolver

Motor	A*	CxD	bxh	E	t1	VxZ Gew.	F	G	K	L	M Ge.	N	O	P Øh6	TK Ø	R Bohrg. Ø
SB-056																
5006	170.5	23x11	4x4	10	12.5	M4x10	6.5	2.5	113	*	*	55	74	40	63	5.5
SB-070																
XX05	158	23x11	4x4	10	12.5	M4x10	8.5	2.5	123	*	*	70	90	60	75	6
XX10	188	23x11	4x4	10	12.5	M4x10	8.5	2.5	123	*	*	70	90	60	75	6
XX15	218	23x11	4x4	10	12.5	M4x10	8.5	2.5	123	*	*	70	90	60	75	6
XX20	248	23x11	4x4	10	12.5	M4x10	8.5	2.5	123	*	*	70	90	60	75	6
SB-105																
XX02	186	40x19	6x6	25	21.5	M6x16	10	3.5	150	51	M6	105	140	95	115	9.5
XX04	229	40x19	6x6	25	21.5	M6x16	10	3.5	150	51	M6	105	140	95	115	9.5
XX06	273	40x19	6x6	25	21.5	M6x16	10	3.5	150	51	M6	105	140	95	115	9.5
XX08	317	40x19	6x6	25	21.5	M6x16	10	3.5	150	51	M6	105	140	95	115	9.5
SB-145																
XX08	231	50x24	8x7	36	27	M8x19	12	3.5	180	79	M8	145	200	130	165	11.5
XX15	292	50x24	8x7	36	27	M8x19	12	3.5	180	79	M8	145	200	130	165	11.5
XX22	354	50x24	8x7	36	27	M8x19	12	3.5	180	79	M8	145	200	130	165	11.5
XX28	416	50x24	8x7	36	27	M8x19	12	3.5	180	79	M8	145	200	130	165	11.5
SB-205																
XX27	273	80x38	10x8	65	41	M12x32	18	4	210	108	M10	205	250	180	215	14
XX50	342	80x38	10x8	65	41	M12x32	18	4	210	108	M10	205	250	180	215	14
XX70	411	80x38	10x8	65	41	M12x32	18	4	210	108	M10	205	250	180	215	14
XX90	480	80x38	10x8	65	41	M12x32	18	4	210	108	M10	205	250	180	215	14

Motor Feedback: SINCOS

Motor	A*	CxD	bxh	E	t1	VxZ Gew.	F	G	X	K	L	M Ge.	N	O	P Øh6	TK Ø	R Bohrg. Ø
SB-105																	
XX02	205	40x19	6x6	25	21.5	M6x16	10	3.5	91	150	51	M6	105	140	95	115	9.5
XX04	248	40x19	6x6	25	21.5	M6x16	10	3.5	91	150	51	M6	105	140	95	115	9.5
XX06	292	40x19	6x6	25	21.5	M6x16	10	3.5	91	150	51	M6	105	140	95	115	9.5
XX08	336	40x19	6x6	25	21.5	M6x16	10	3.5	91	150	51	M6	105	140	95	115	9.5
SB-145																	
XX08	250	50x24	8x7	36	27	M8x19	12	3.5	95	180	79	M8	145	200	130	165	11.5
XX15	311	50x24	8x7	36	27	M8x19	12	3.5	95	180	79	M8	145	200	130	165	11.5
XX22	373	50x24	8x7	36	27	M8x19	12	3.5	95	180	79	M8	145	200	130	165	11.5
XX28	435	50x24	8x7	36	27	M8x19	12	3.5	95	180	79	M8	145	200	130	165	11.5
SB-205																	
XX27	292	80x38	10x8	65	41	M12x32	18	4	95	210	108	M10	205	250	180	215	14
XX50	361	80x38	10x8	65	41	M12x32	18	4	95	210	108	M10	205	250	180	215	14
XX70	430	80x38	10x8	65	41	M12x32	18	4	95	210	108	M10	205	250	180	215	14
XX90	499	80x38	10x8	65	41	M12x32	18	4	95	210	108	M10	205	250	180	215	14

* For motors with brake, the motor length A must be increased by the following values:

SB056	51
SB070	56
SB105	64
SB145	74
SB205	99

Tolerances:

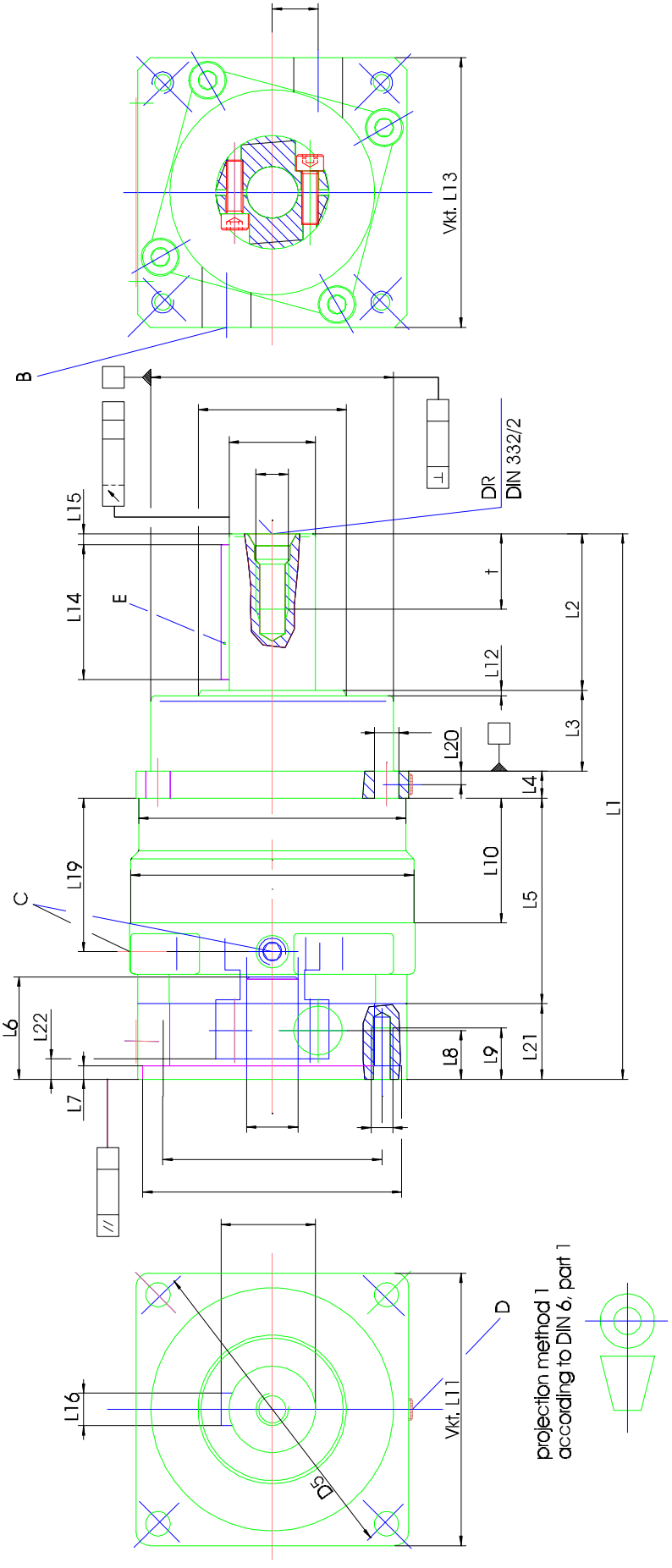
Shaft diameter D

SB070	h6
SB105	j6
SB145	j6
SB205	k6

Feather groove

according to DIN 6885, fitting tight
Tolerance P9

5.2.3 Mechanical Data of the Gearbox



Size			SP 060		SP 075		SP 100		SP 140		SP 180	
Number of gear levels			1	2	1	2	1	2	1	2	1	2
D1	Centring	g6	60	60	70	70	90	90	130	130	160	160
D2	Gear nut		30	30	38	38	55	55	70	70	90	90
D3	Output shaft	k6	16	16	22	22	32	32	40	40	55	55
D4	Bore holes for fixing	4x	5.5	5.5	6.6	6.6	9	9	11	11	13	13
D5	Whole circle on drive shaft		68	68	85	85	120	120	165	165	215	215
D6	Max. boring for motor shaft	F7	14	14	19	19	28	28	35	35	48	48
D7	Free revolution											
D8	Whole circle for motor											
D9	Screwing thread for motor											
D10	Gearbox casing		58.5	58.5	74	74	99	99	124	124	180	180
L1	Total length	±2	129	149	156	182.5	202	234.5	256.5	296.5	297	315.5
L2	Length of output shaft		28	28	36	36	58	58	82	82	82	82
L3	Centring collar of output shaft		20	20	20	20	30	30	30	30	30	30
L4	Flange size		6	6	7	7	10	10	12	12	15	15
L5	Gearbox casing		60	80	71	97.5	76	108.5	102	142	132.5	158
L6	Length of motor shaft	min. max.	15 30	15 30	23 40	23 40	30 50	30 50	32 60	32 60	45 82	45 82
L7	Depth of free revolution	+0.5	4	4	4	4	5	5	6	6	6	6
L8	Position of bore for mounting		9.4	9.4	14	14	18	18	18	18	24.5	18
L9	Depth of screw thread		9	9	12	12	19	19	21	21	25	21
L10	Gearbox casing		44	64	51	77.5	50	82.5	66.5	106.5	84.5	122.5
L11	Square output shaft	±1	62	62	76	76	101	101	141	141	182	182
L12	Collar width		2	2	2	2	2	2	3	3	3	3
L13	Smallest square shaft adapter plate	±1	60	60	80	80	100	100	140	140	190	140
L14	Feather length 1)		25	25	32	32	50	50	70	70	70	70
L15	Position of feather		2	2	2	2	4	4	5	5	6	6
L16	Feather width	h9	5	5	6	6	10	10	12	12	16	16
L17	Output shaft with feather		18	18	24.5	24.5	35	35	43	43	59	59
L18	Position of bore for mounting	*	10	10	12	12	17	17	19	19	26	19
L19	Position of closing screw for input shaft		48.3	68.3	57	83.5	57	89.5	74.5	114.5	100.5	130.5
L20	Position of closing screw for output shaft		-	-	-	-	5	5	6	6	12	12
L21	Thickness of adapter plate		15	15	22	22	28	28	30.5	30.5	37.5	30.5
a	Deviations from concentric and cross movements		0.025	0.025	0.025	0.025	0.025	0.025	0.04	0.04	0.04	0.04
B	Opening for mounting		8	8	15	15	18	18	20	20	20	20
C	Closing screw for input shaft		1xM6		1xM8x1		3xM12x1.5		3XM12x1.5		3xM12x1.5	
D	Closing screw for output shaft		-		-		1xM8x1		1xM8x1		1xM8x1	
E	Feather		feather according to DIN 6885 sheet 1, form A									
M	Centre bore		M5	M5	M8	M8	M12	M12	M16	M16	M20	M20
t	Thread depth of centre bore		12.5	12.5	19	19	28	28	36	36	42	42

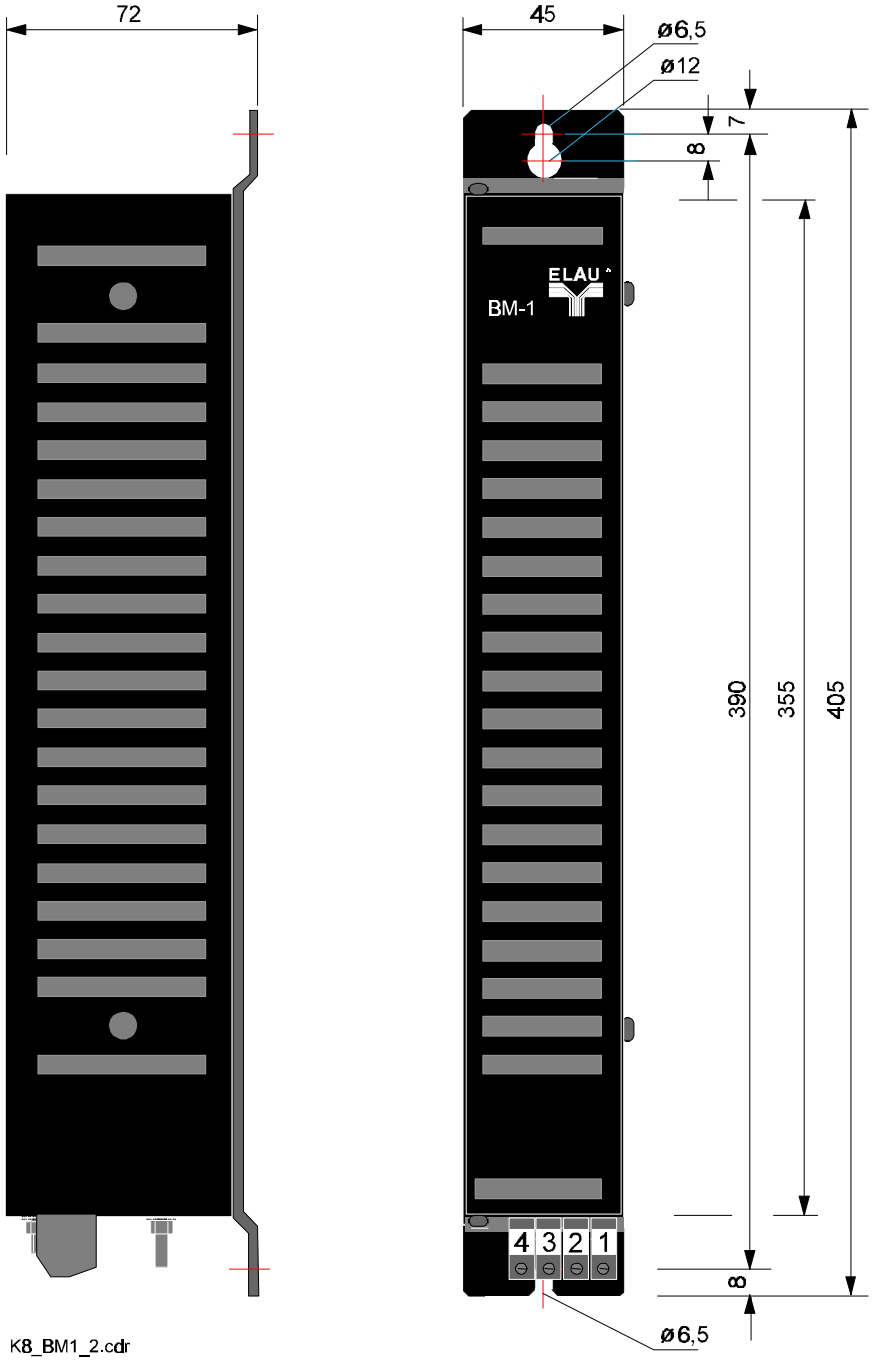
* Measurements may divert for very small motors.
1) In case of reversing operation and high burden on the gearbox, we recommend smooth output shafts.

5.3 Bleeder Modules BM-1 / BM-2

5.3.1 Bleeder Module BM-1

Resistance value	27 Ω	47 Ω
Continuous bleeder output	170 W	170 W
Peak bleeder output	8 kW	5 kW

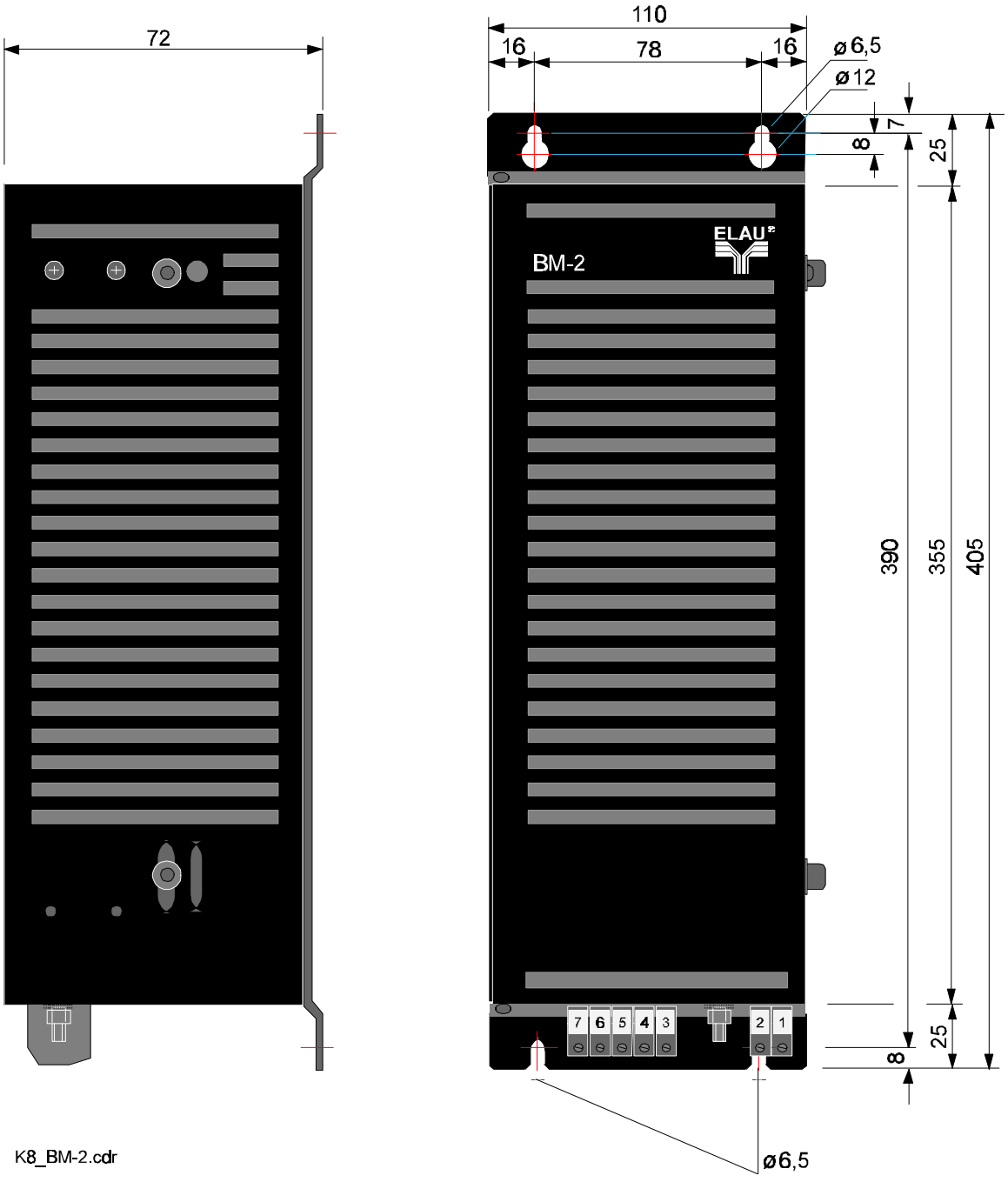
Clamp	Assignment		
1	Resistance		
2	Resistance		
3	Temperature feeler	connection A	normally-closed contact (60V DC / 1A)
4	Temperature feeler	connection B	
Bolt M5	Earth conductor		



5.3.2 Bleeder Module BM-2

Resistance value	10 Ω	13.5 Ω
Continuous bleeder power	750 W	500 W
Peak bleeder power	22 kW	16 kW

Clamp	Assignment		
1	Resistance		
2	Resistance		
3	Temperature feeler	connection A	normally closed contact (60V DC / 1A)
4	Temperature feeler	connection B	
5	0V	fan	
6	21 - 27V DC	fan	
7	27 - 33V DC	fan	
Bolt M5	Earth conductor		



5.4 Capacitor Module KM-1

Function

The capacitor module is to increase the DC circuit capacity of the positioning motor controller PMC-2. This has the following effects:

- For applications where the drive is frequently slowed and then accelerated, the brake energy is stored in the capacitor module and not transformed into heat via the bleeder resistor. This reduces the effective power intake of the PMC-2 and the bleeder stress and thus the warming of the PMC-2. The necessary energy for the subsequent acceleration process is provided mostly by the capacitor module.

- For applications where the motor needs to complete its movement after a failure of the main power supply, the capacitor module can provide the required energy.

The layout of a PMC-2 system with capacitor module KM-1 depends to a large extent on the respective application. If you have any questions about KM-1, please contact the ELAU application department.

Additional notes for working with KM-1

Use as directed

The capacitor module KM-1 must be used only for the applications mentioned in the description and only in combination with the positioning motor controller PMC-2.

The appliance described was developed, produced, tested and documented in compliance with the valid safety standards.

If the handling instructions and safety notes for projecting, assembly, use as directed and maintenance are observed, the product as a rule involves no risk of material damage or hazard to people's health.

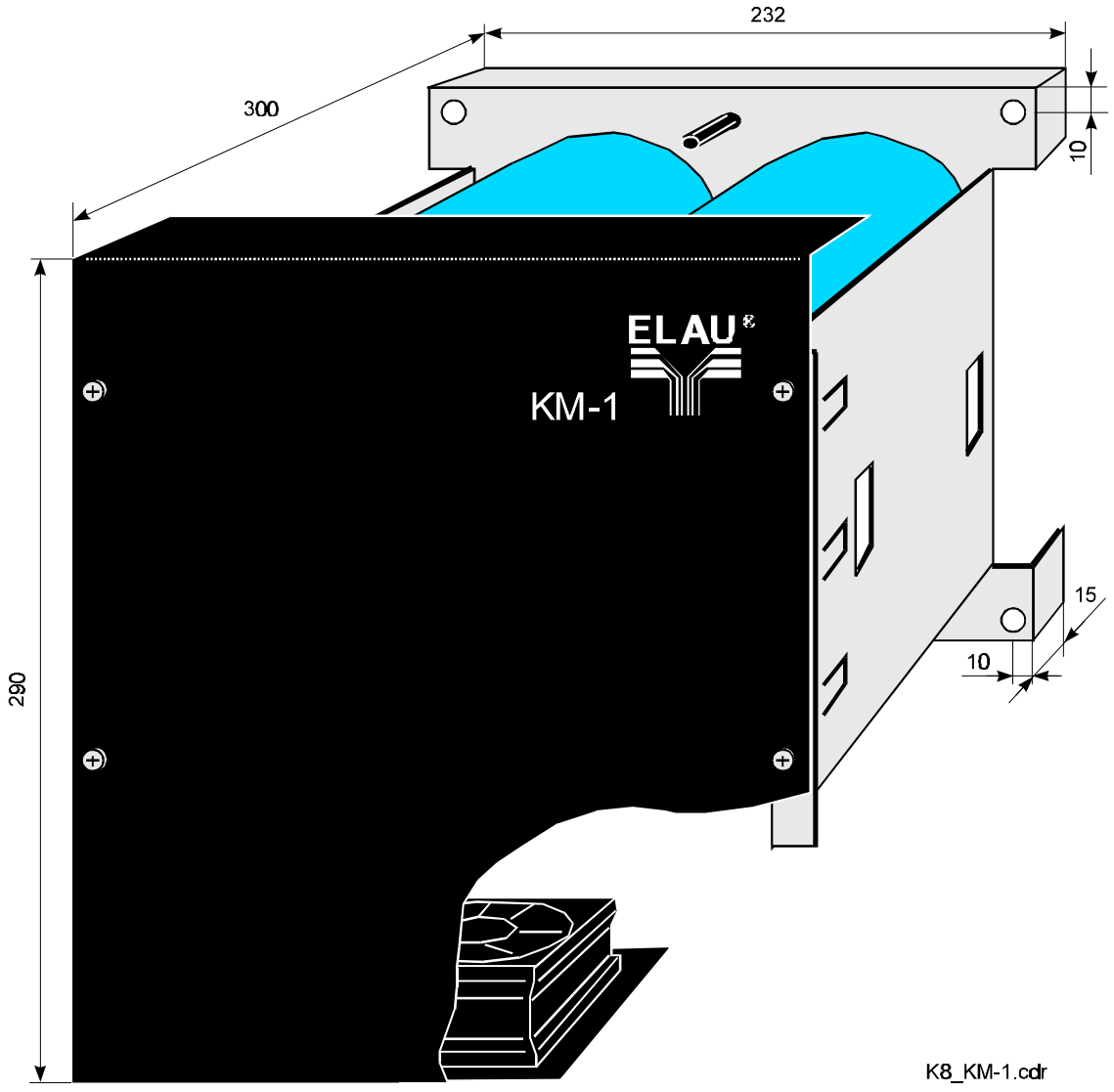
Safety notes

 **CAUTION**	The discharge time of the KM-1 by internal discharge resistors is >10min! Before working at the KM-1, you must make sure that the module is discharged. A quick discharge (approx. 5s) by means of an integrated power resistor is possible (see application proposals). During the discharge time, the capacitor module KM-1 still has enough energy stored to cause uncontrolled movements of the drive in case of an error, although the mains supply is switched off. Therefore the capacitor module must be completely discharged before you do any work on the drive. In operating mode T1, the capacitor module must be discharged to the lower T1 DC-circuit voltage. The DC-circuit voltage must be controlled by the superior control level by means of an external voltage monitor.

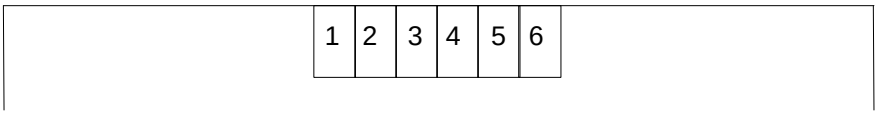
Technical data

The capacitor module is designed for connection to a positioning motor controller PMC-2 with a rated current of 8A maximum.

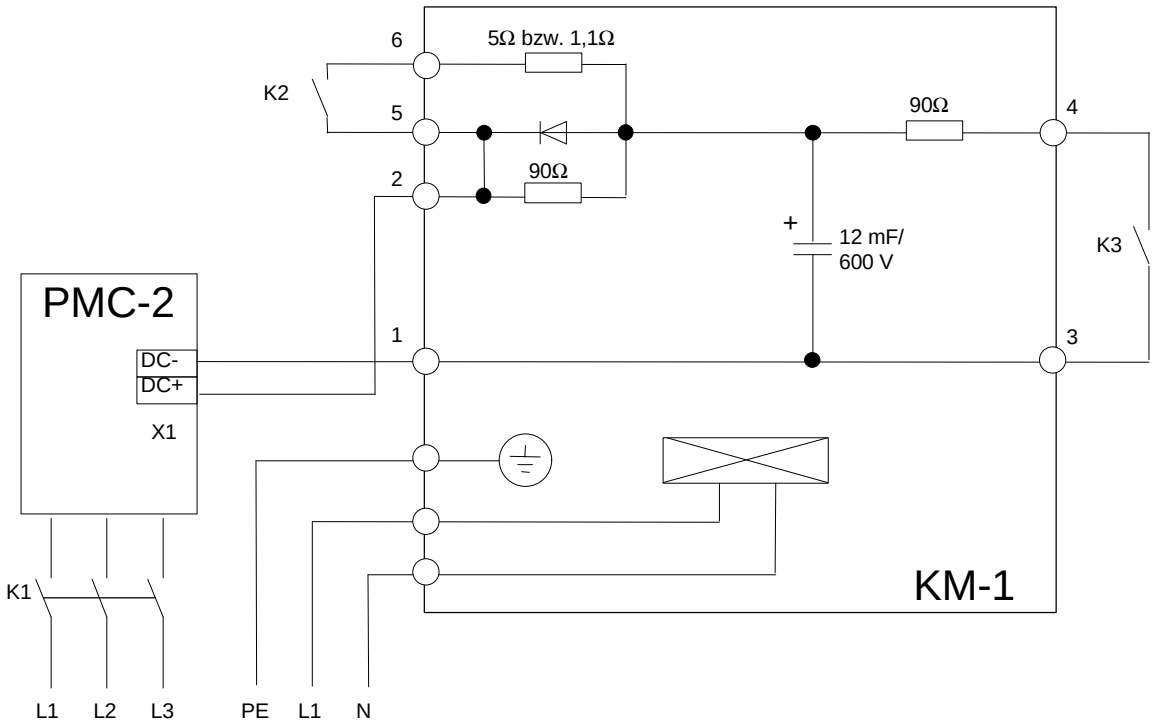
Rated capacity	12 mF
Rated voltage	600 VDC
Charge resistor	90 Ω (bridged 5 Ω or 1.1 Ω)
Discharge resistor	90 Ω
Compulsory ventilation	230 VAC



Allocation of connections and application proposal



Connector	Meaning
1	DC- (PMC-2)
2	DC+ (PMC-2)
3	A normally open contact for discharge
4	B over 90 Ω
5	A normally open contact for bridge
6	B of the charge resistor (90 Ω) with 5 Ω



K1	Mains contactor	AC
K2	Charge contactor	DC 600V / ≥10A
K3	Discharge contactor	DC 600V / ≥10A

Note:
The "bridged" charge resistance of KM-1 for PMC-2/16 and PMC-2/25 is 1.1Ω.
The DC- and DC+ wire must be twisted.

DC power contactors (e.g. Siemens 3TC44) must be used for K2 and K3. The following procedures must be followed for charging and discharging.

Charging procedure (switch-on)

K2, K3 are open. Controlled by the PMC-2, K1 starts working and switches on the main power supply; the capacitor module is charged via a resistance of 90 Ω. The charge may be bridged by K2 with 5 Ω not before ≥ 5s. Then the drive can be operated.

Failure of main power supply:

After a failure of the main power supply, K1, K2 and K3 are open. The capacitor module feeds the DC-circuit of the PMC-2 via an internal diode.

Discharging procedure (switch-off or T1 operation)

To discharge the KM-1 (e.g. for T1 operation), K1 and K2 must be opened. By closing K3, the capacitor module is discharged via 90 Ω. The discharging procedure takes approx. 5s.

CAUTION	By locking the contactors externally, it must be ensured that K1 and K3 are never closed at the same time and that K2 is closed not less than 5s after K1 starts working. Due to the limited power dissipation of the charging and discharging resistors, the interval between charging and discharging procedures must be at least 15s.

5.5 24V DC Power Supply Unit

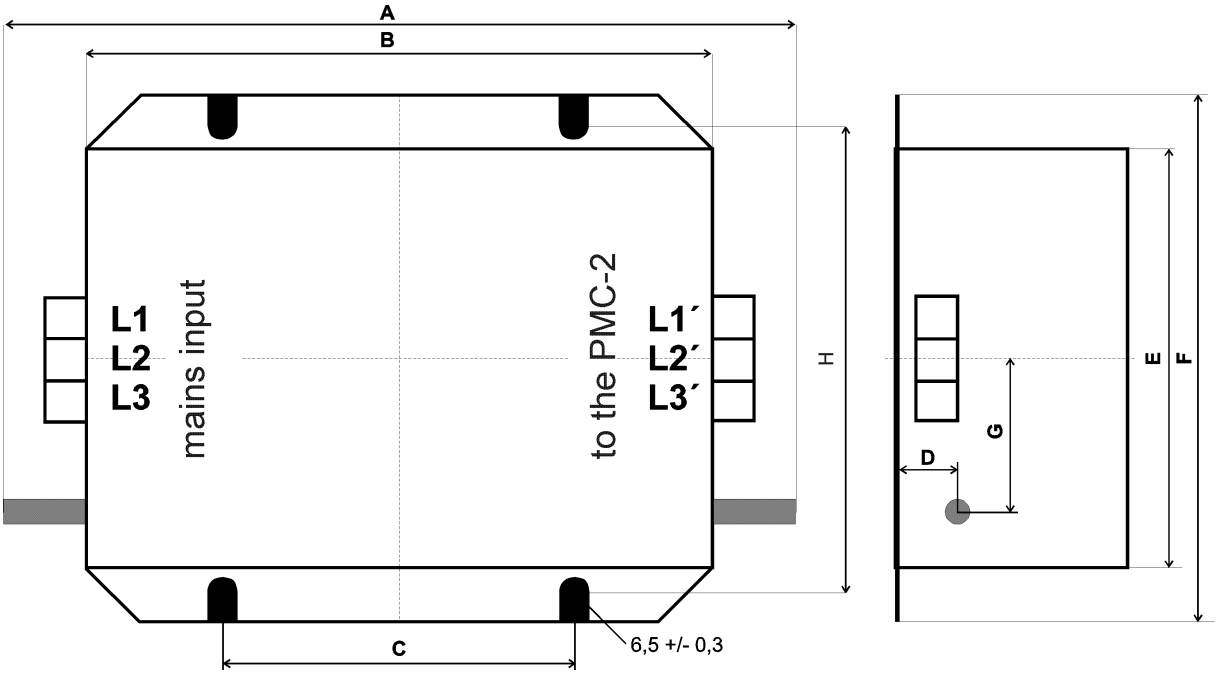
The power supply unit in the switching cabinet can be used as 24V DC power supply unit for the PMC-2 appliances.

The 24V DC must comply with the following technical data:

Voltage	24V DC -10% / +25%
Current **- without optional modules** **- with all optional modules and encoders**	 1 A per PMC-2 at 24 V 2 A per PMC-2 at 24 V
Residual ripple	< 5%

5.6 Mains Filter

	Art.No. FI07838	Art.No. FI07841
Rated current @50°C	8 A	25 A
Temperature range	+5°C to +55°C	+5°C to +55°C
Size A in mm	191	221
B in mm	151	181
C in mm	85 ±0.3	115 ±0.3
D in mm	15	17
E in mm	101	86
F in mm	127	116
G in mm	37	30
H in mm	112 +0/-1	100 +0/-1



Netzfilter_FI07841_deutsch_0798.cdr

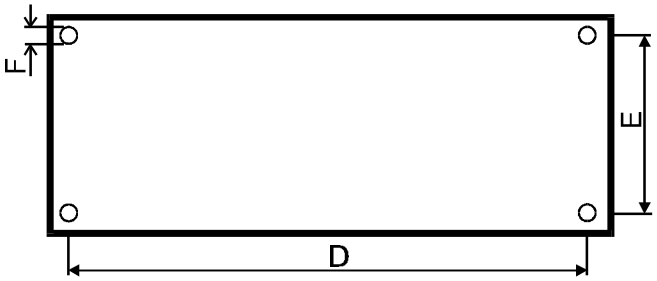
Notes:
For further notes, see chapter 6.4.2 ”EMT”.
If you need mains filters with higher rated currents, please contact our application department.

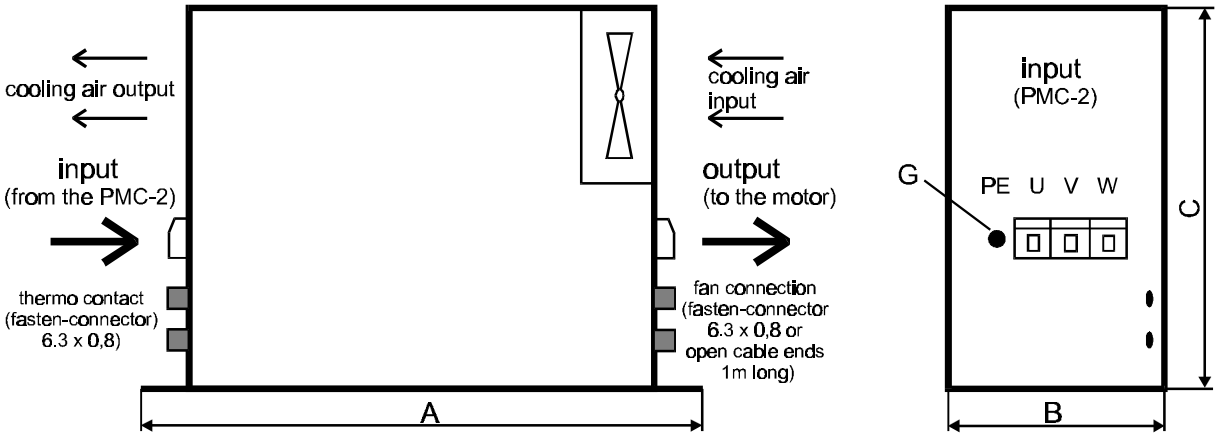
5.7 Motor Filter

Features of the motor filter:
- du/dt restriction
- reduction of excess voltage
- reduction of electromagnetic distortion at frequency converters with DC circuit

CAUTION	For motor cable lengths of more than 40 m, please contact our application department.

	Art.No. FI07837	Art.No. FI07840
Rated current @50°C	8 A	24 A
Temperature range	+5°C to +55°C	+5°C to +55°C
Minimum triggering level of thermo contact	approx. 150°C	approx. 120°C
Fan	24 V DC / 110 mA (2.6 W)	24 V DC / 140 mA (3.4 W)
Weight	2.1 kg	7.7 kg
Size A in mm	220 ±1	350 ±1.5
B in mm	65 ±0.6	110 ±0.8
C in mm	140 ±0.8	190 ±1
D in mm	200 ±0.5	330 ±0.5
E in mm	40 ±0.3	70 ±0.3
F in mm	5.3 ±0.2	6.5 ±0.2
G	M4	M6





Mot_filt.cdr

CAUTION	Input and output of the filters must not be interchanged.

VORSICHT hohe Temperatur
warning high temperature
Oberfläche des Gerätes im Betriebszustand
nicht berühren
do not touch to this surface
under operation conditions

Note:
For further notes, see chapter 6.4.2 ”Electromagnetic Tolerance (EMT)”.

5.8 Transformers

A transformer is not needed unless the mains voltage is beyond the permissible rated collecting voltage of the PMC-2 (see 5.1.2 "Technical Data").

For earthed networks, the voltage can be adjusted by means of an autotransformer; for unearthed networks an isolating transformer must be used in order to avoid excess voltage between outer conductor and earth.

To choose a suitable transformer, you need to know the connecting power "S".

Connecting power S:
The connecting power S gives the mains connection power of the PMC-2 for an average useful torque of up to 25% of n_{NM} and an on-load torque which is equivalent to the standstill torque M_{0M}.

$$S_E = \frac{2 * p * M_{NM} * n_{average}}{60 * 1000} * k$$

$$S_E = \frac{M_{NM} * n_{average}}{9549} * k$$

S_E connecting power [kVA]

M_{eff} effective torque [Nm]

$n_{average}$ average speed (arithmetic average) [min^{-1}]

k correction factor = 1.6 for rated connecting power

For multiple-axle systems, the following dimensioning has been found to be suitable in practice:

$$S_{Etotal} = \frac{S_{E1} + S_{E2} + S_{E3} + S_{E4} + ... + S_{En}}{f} + 1kVA$$

S_{Etotal} sum of continuous power input [kVA]

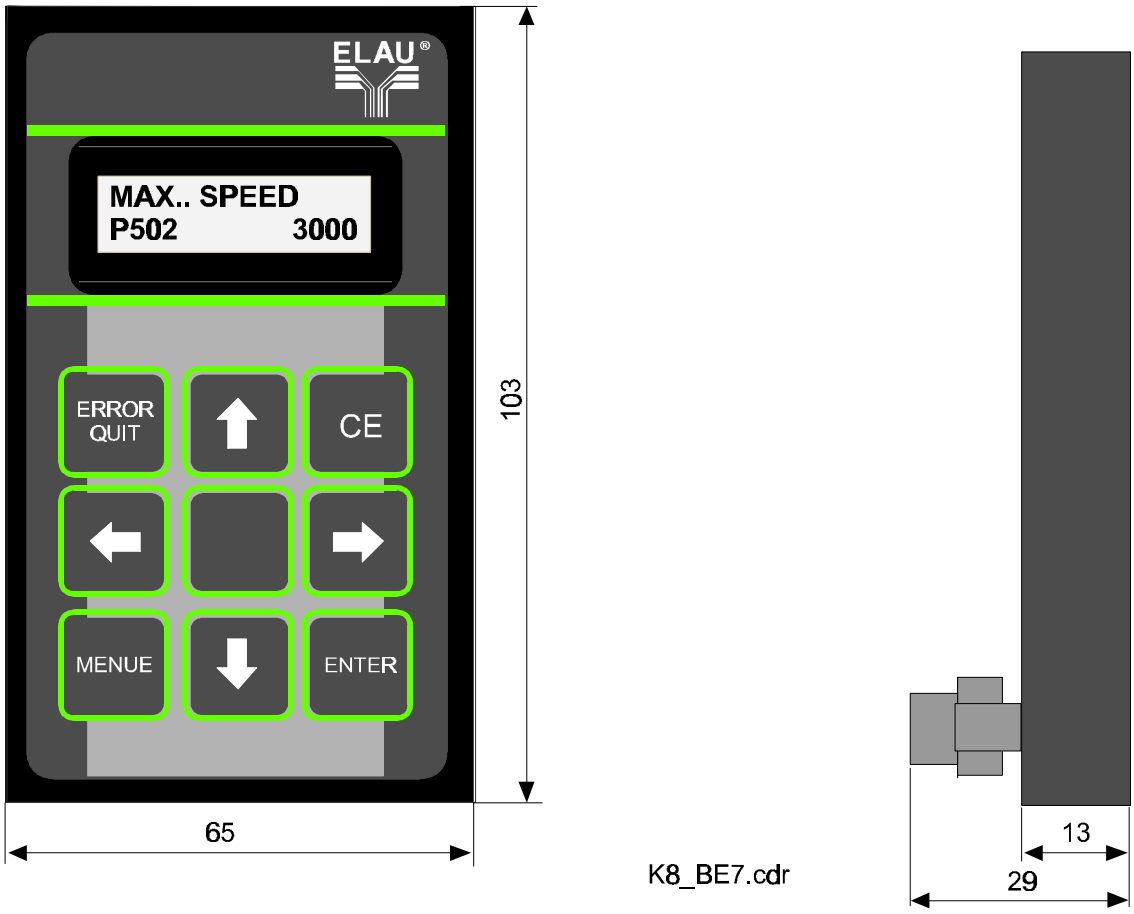
S_{E1} ... S_{En} power input of the individual servo drives [kVA]

f factor of simultaneousness

Number of axles	1	2	3	4	5	6
f	1.0	1.15	1.32	1.75	2.0	2.25

5.9 Diagnosing Unit BE-7

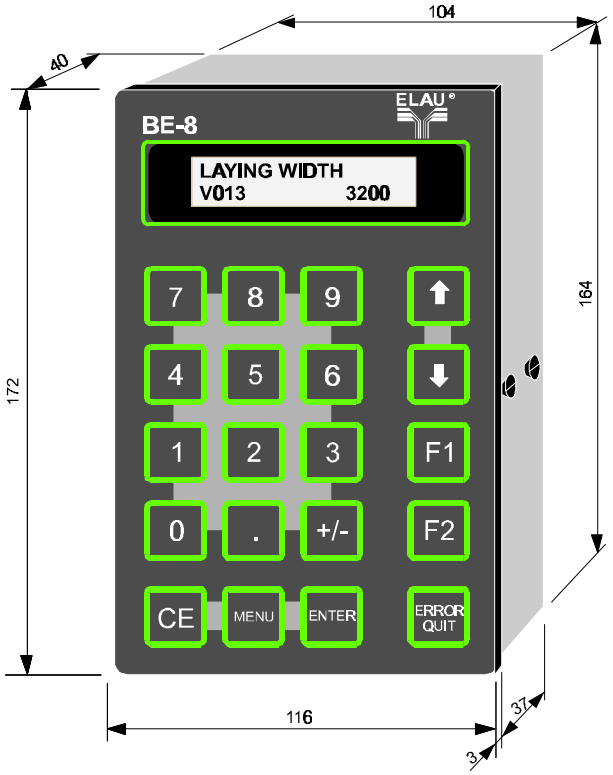
Display	LCD display Supertwist 2 lines with 16 characters each digit height 3.15mm
Input	short-stroke film keyboard 8 keys
Connector	25-pole D-Sub pin
Weight	approx. 0.15 kg



5.10 Operating Units

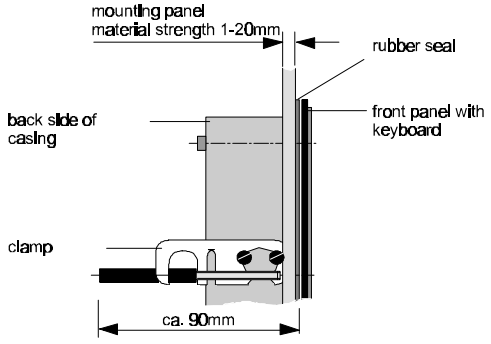
5.10.1 BE-8

Display	LCD display Supertwist 2 lines with 16 characters each digit height 5.5mm
Input	short-stroke film keyboard 20 keys
Interface	RS 485 15-pole D-Sub max. cable length 10m
Power supply	+5V via interface cable
Weight	approx. 0.8 kg



FIxIng!

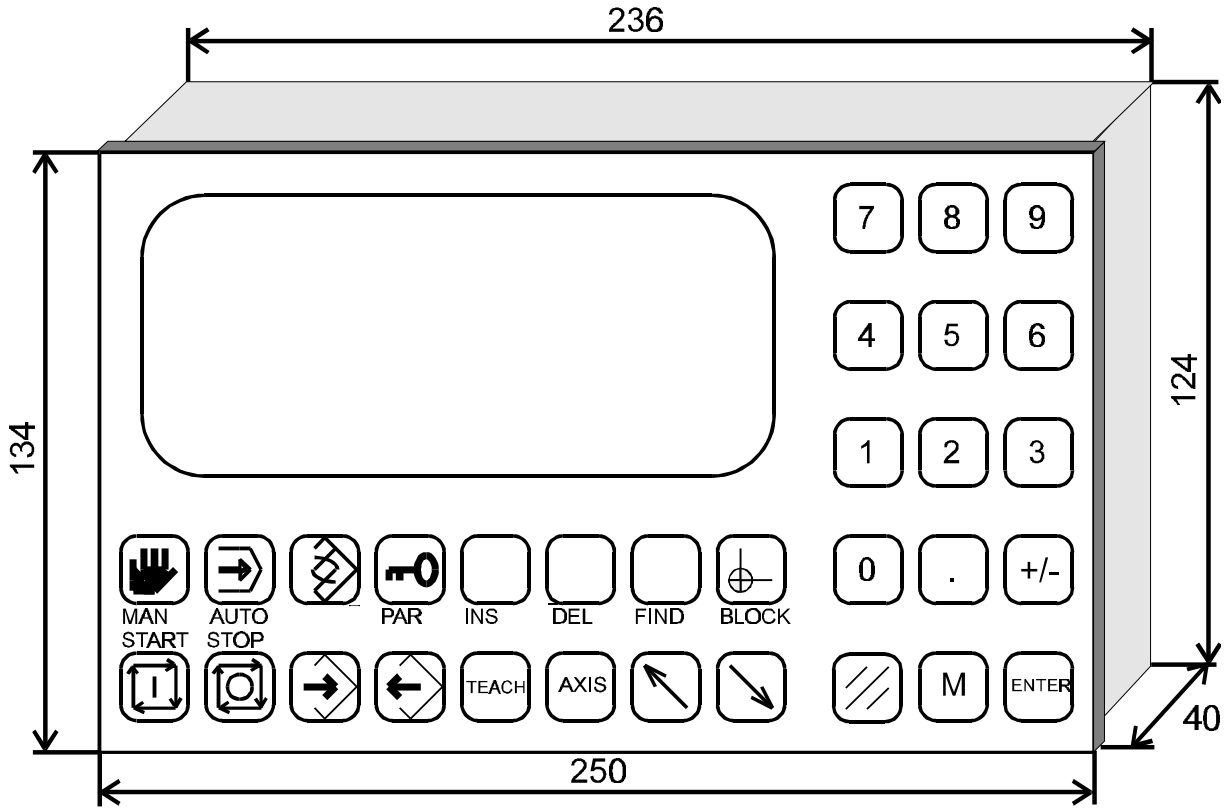
The appliance is plugged into the mounting panel from the front side and pressed onto the panel by two clamps reaching from behind. Make sure the rupper seal Is Inserted as requIred!
Cut-out for mountIng: 108 +/- 1
166 +/- 1



K8_BE8.cdr

5.10.2 BE-1

Display	LCD display Supertwist 4 lines with 20 characters each digit height 8mm
Input	short-stroke film keyboard 31 keys
Interface	RS 485 15 -pole D-Sub pin max. cable length 50m
Power supply	U_N = 24V DC
Power input	I_{max} = 200mA
Weight	approx. 1.2 kg



K8_BE1.cdr

5.11 PC Software EPAS-3

EPAS-3 is available for programming and commissioning the PMC-2.

The customer-specific application of the PMC-2 is implemented with the help of the ELAU-Control-Language (ECL), which has proven successful many times in the positioning controls SX-1, SX-2 and SX-3.

Thanks to its multi-tasking ability, ECL-3, for the product family PMC-2, gives the user a powerful tool. The compiled ECL-3 program is executed by the ECL run time system. Up to 8 parallel ECL program parts can be executed quasi simultaneously.

For example, one ECL program part takes over positioning tasks, while another part focuses on control functions. A high processing speed is achieved because the ECL program is stored in the machine code of the microprocessor.

The break-down into individual commands and semi-textual language elements facilitates the creation of easily comprehensible programs.

ECL-3 offers a comprehensive range of commands:

- commands for program organisation
- relative and absolute positioning commands
- synchronous positioning (electric gears, cam plate)
- mark positioning
- variable transfer commands
- time commands
- logic and arithmetic commands

The program is created on a menu-based programming surface on an IBM-compatible PC with EPAS-3.

Features of EPAS-3:

- pull-down-menus according to SAA standard
- operation by mouse or keyboard
- ECL-3 editor with syntax check
- parameter editor
- variable editor
- archiving
- printing
- window system

Program, parameters, curve data and variables can be easily transmitted to the PMC-2 by means of axle module lists.

EPAS-3 is in available in different licence versions:

- Single licence (Art. No.: 20630040)
- network licence (Art. No.: 20630041)
- OEM licence (Art. No.: 20630039)
- UPDATE version (Art. No.: 20630042)

A version for Windows 95 and Windows NT is being prepared (2nd quarter of 1998)

6 Planning the Switching Cabinet

6.1 Installation Notes

6.1.1 Type of Protection

CAUTION	To protect the appliance (especially from metallic powder deposit, oil, humidity and strong electromagnetic disturbance, as well as to adhere to the permissible surrounding temperature), make sure that the type of protection installed matches the surrounding conditions.

6.1.2 ESD Protection Measures

CAUTION	With increasing miniaturisation, electro-static discharge is a threat to the highly integrated components used if no protection measures are taken.

Electro-statically endangered components and assembly groups are furnished with the warning label shown here (or a similar one).

Observe the following rules of behaviour:
- avoid any contact with pins or tracks when touching components
- wear a special wrist band when exchanging components
- lay the components on a conducting, earthed pad
- transport the PMC-2 only in an appropriate packaging (original packaging)

6.2 Installation

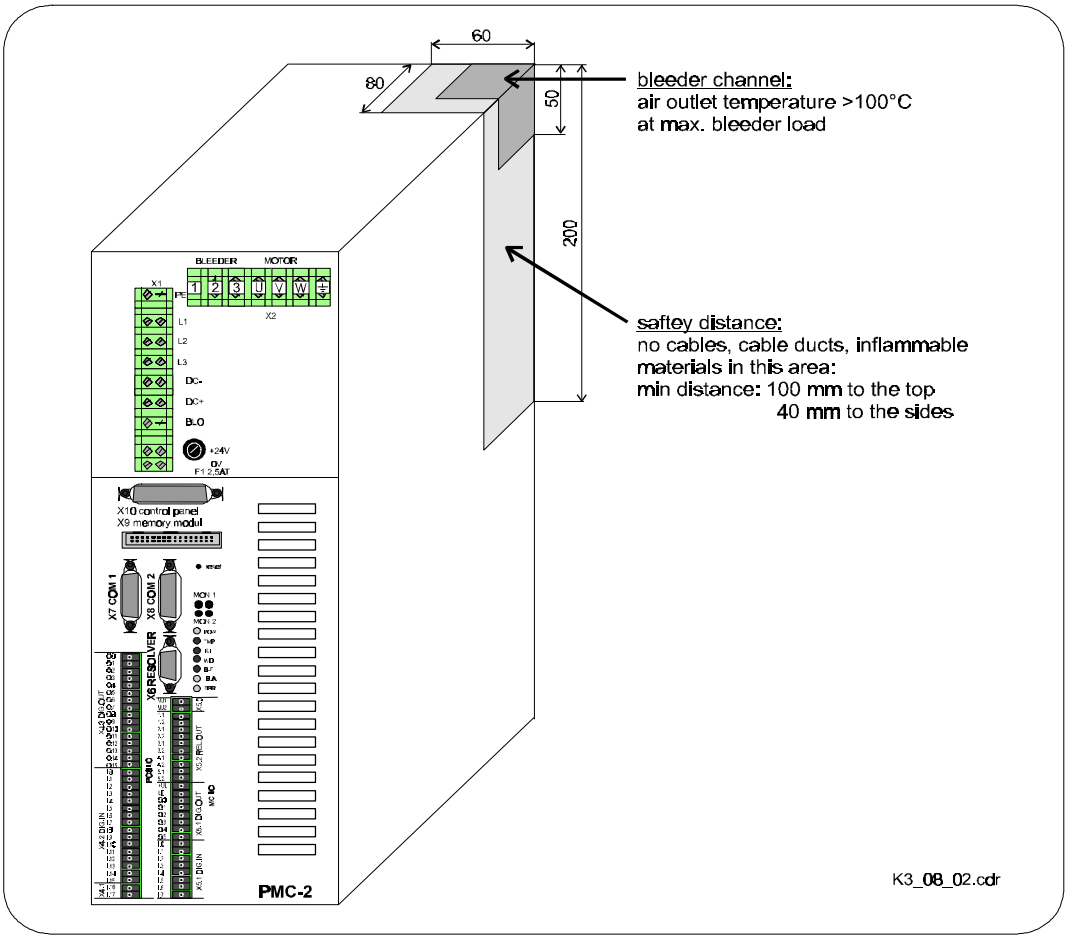
- The appliances must be installed perpendicularly, with power connections on the upper side.
- Only one motor maybe connected to the PMC-2.

ACHTUNG HOCHSPANNUNG!
warning high voltage!
Vor Arbeiten am Gerät, Netzanschluß trennen. Entladezeit > 1min.
disconnect from mains supply before working on this equipment. electric discharge > 1min

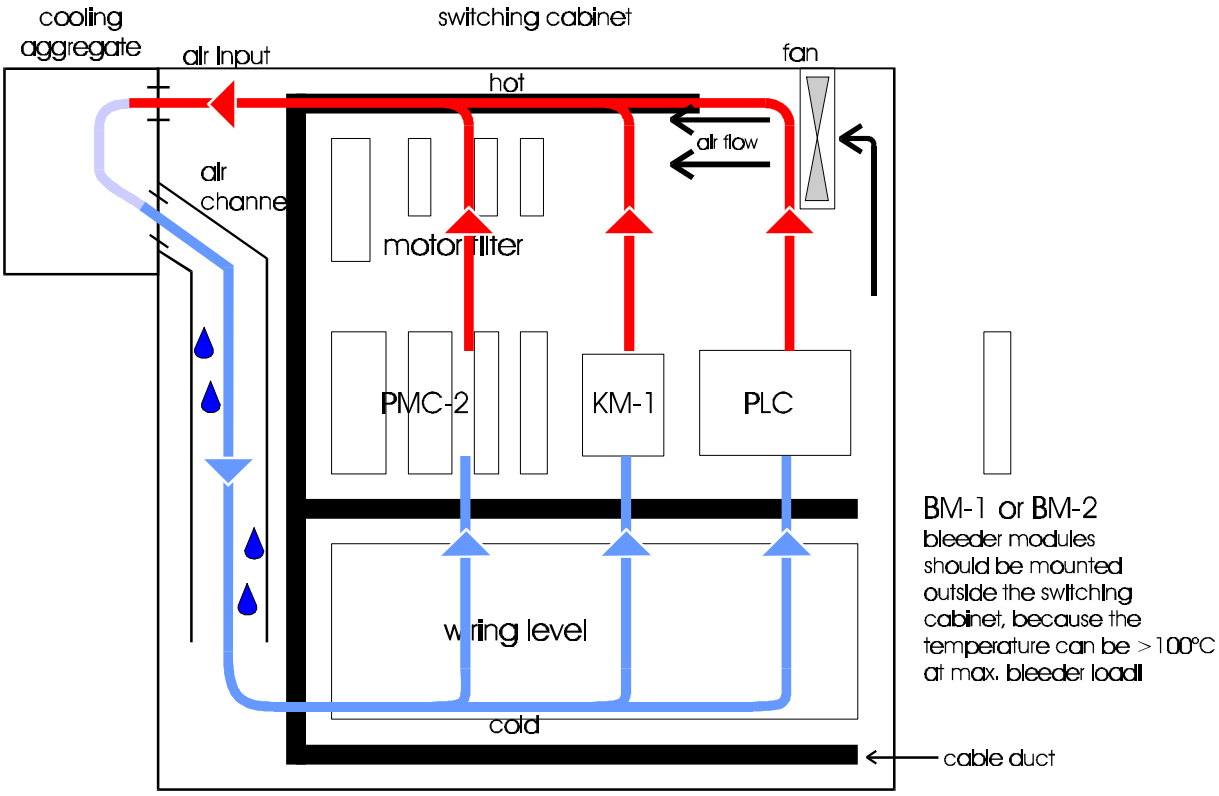
Caution!
At maximum brake power, the air outlet temperature of the PMC-2 may be >100°C.

- 100 mm of free space must be provided on the top, bottom and front side!
- A free air supply to the fan must be guaranteed!
- External bleeders should be at a distance of at least 100 mm from all adjacent parts, since they can get very hot; it is even better to install them outside the switching cabinet.

ACHTUNG hohe Temperatur
warning high temperature
Oberfläche des Gerätes im Betriebszustand nicht berühren
do not touch to this surface under operation conditions



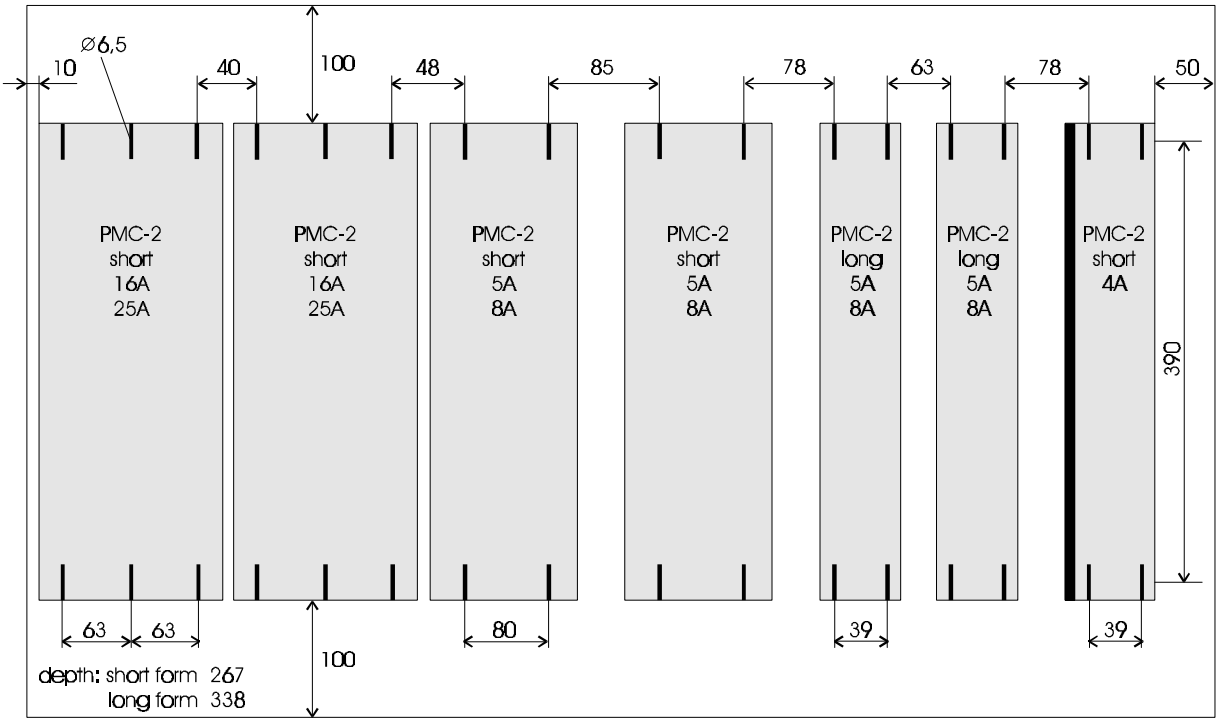
Example for a switching cabinet with ventilation



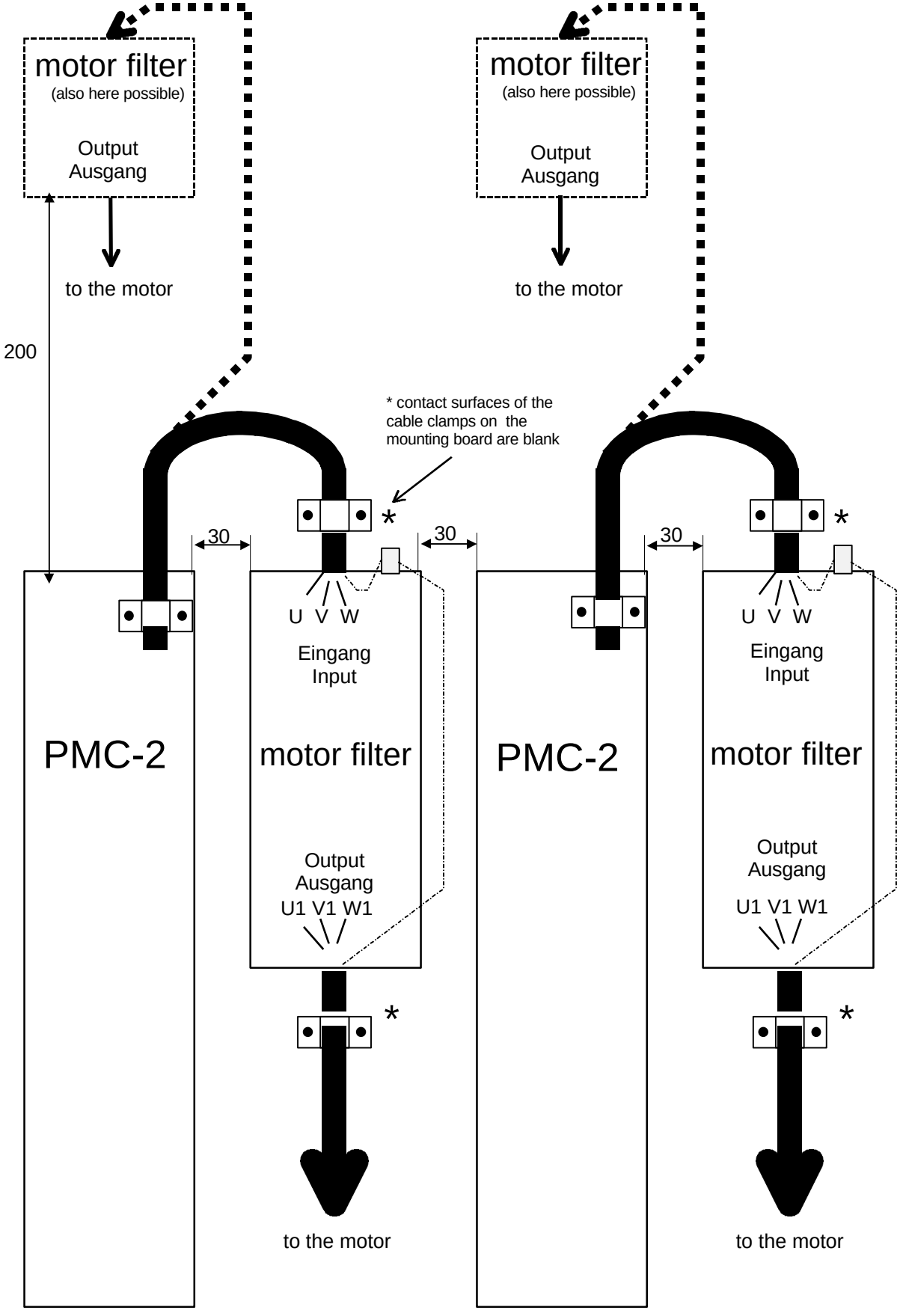
Notes:

- Distance between appliances: (casing to casing)
  - short form 4A, 5A, 8A >40mm
  - long form 5A, 8A >30mm
  - short form 16A, 25A >10mm
- If a DPS-1 optional module (PROFIBUS-DP) is used, the minimum distance for the long form must be increased due to the connector plugs.
- For fixing se cylindrical screws M6 (hexagon socket screws) for fixing and a hexagonal screwdriver size 5.
- If there are more than three PMC-2 in the switching cabinet, a fan is required to ensure sufficient air circulation.

Mounting scheme for the PMC-2 with minimum distances:



Installation scheme for the motor filter with minimum distances



6.3 Use of Cooling Aggregates

CAUTION	Cooling aggregates installed and operated without the necessary expertise endanger the electronic components in the switching cabinet due to thawing and condensing water.

Danger due to thawing

Moist and hot air penetrates the switching cabinet and in the cooling process precipitates thaw on the electronic components located there.

Skilful use of cooling aggregates

- When using cooling aggregates, use only firmly insulated switching cabinets, so that there can be no thaw due to moist and hot air penetrating from outside!
- In case switching cabinets are operated with open doors (commissioning, service, ...) it must be made sure that, after the doors are closed, the electronic components are at no time cooler than the air inside the switching cabinet. Otherwise thaw may precipitate. Therefore the cooling aggregate must stay on even if the plant is switched off, so that the temperature of the air inside the switching cabinet and the electronic components installed remains on a steady level.
- Set cooling aggregates with fixed temperature setting to 40°C. Not less!
- Set cooling aggregates with follow-up temperature control in such a way that the temperature inside the switching cabinet is never lower than the outside temperature. Set the temperature limit at 40°C!

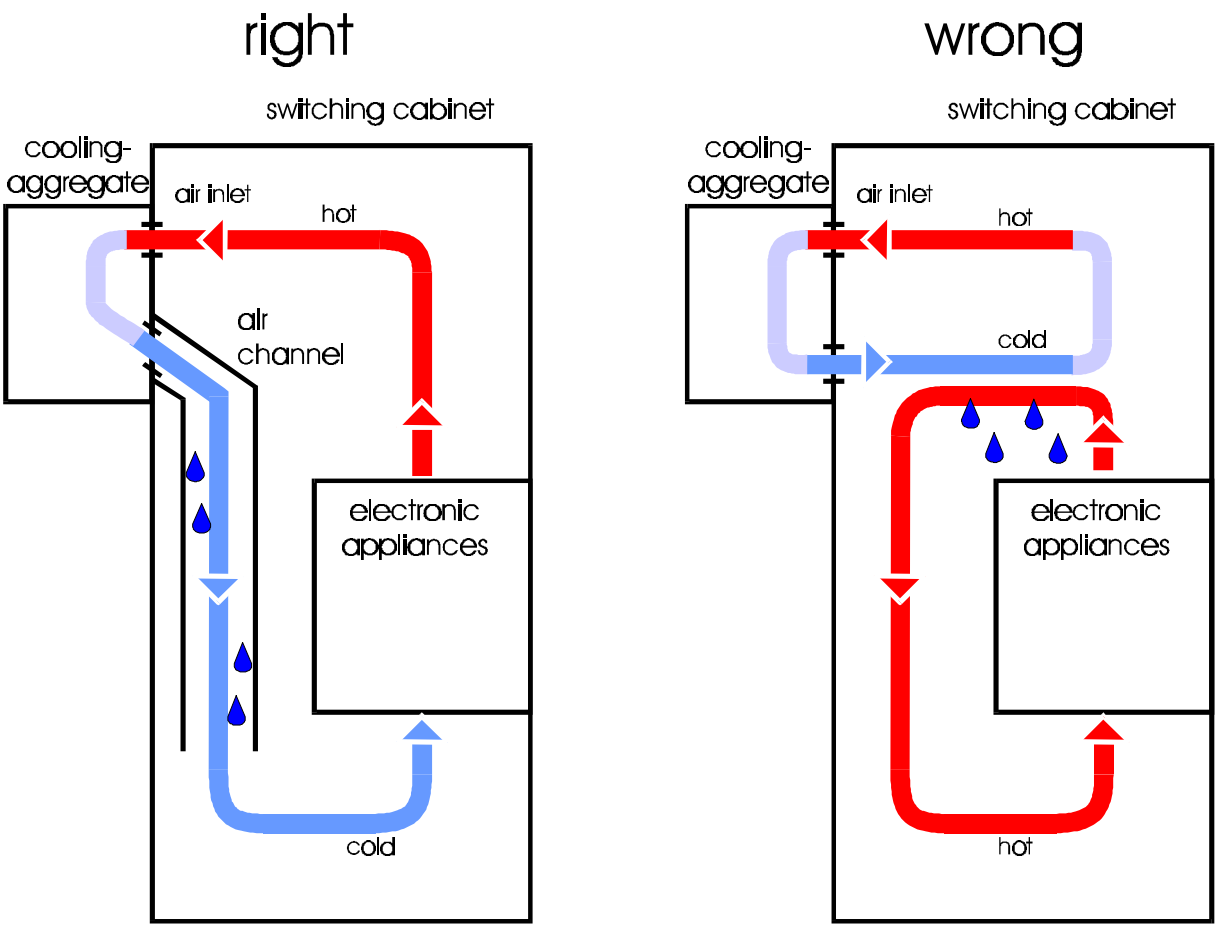
Danger due to condensing water

If the aggregate is placed unfavourably, the condensing water, which always occurs at cooling aggregates, may drip into the electronic components installed or be sprayed in with the cooling air flow.

How to avoid dripping or spray water

- Always place cooling aggregates in such a way that the condensing water incurred cannot drip into the electronic components installed. Cooling aggregates on top of the switching cabinet require a special design of the switching cabinet!
- Design the switching cabinet in such a way that the fan of the aggregate cannot spray the collected condensed water onto the electronic components installed!

CAUTION	Make sure that no condensation water drips from the cooling aggregate into the electronic components installed! Make sure the temperature setting of the cooling aggregates is correct!



Kuehlagg.cdr

6.4 Wiring Notes

6.4.1 In General

For wiring, the set minimum cross-sections, shielding and earthing must be observed.
The branching conditions shown must be observed. If there are, for example, two parallel transmissions starting from one point, it is not allowed to use only one transmission and branch it at a later point, because this may cause induction loops (disturbance senders and antennas) or distorting shifts of potential.

ELAU as a system supplier provides the ready-made cables.

CAUTION	The minimum bending radius for all ELAU cables is 10 x cable diameter.

If no ELAU cables are used, observe the following cross sections:

Admissible cable cross sections in dependence of the current (VDE 0113) installation type C:

1,5 mm^2	to	15A
2,5 mm^2	to	21A
4 mm^2	to	28A

PMC-2 type	**4A**	**5A**	**8A**	**16A**	**25A**
Mains cable in mm^2	1.5	1.5	1.5	2.5	4
Earth conductor to CEP in mm^2 (flexible)	10	10	10	10	10
Control signals in mm^2	0.5	0.5	0.5	0.5	0.5
DC-circuit in mm^2	2.5	2.5	2.5	4	4
External bleeder in mm^2	1.5	1.5	1.5	2.5	2.5

Motor type	**SB-056**	**SB-070**	**SB-105**	**SB-145**	**SB-205**
Motor cable in mm^2	1.5	1.5	1.5	1.5 / 2.5 / 4	2.5 / 4

The following cables must all be separately laid and shielded:

- Motor cable
- Resolver cable
- Encoder cable
- Serial interface

	Check the wiring before switch-on. To avoid errors, we recommend you to order the connecting cables together with the PMC-2.

Frequent errors are:

- Wrong shielding of transmissions
- Frame or earth circuits
- Change by mistake of the motor phases
- Change by mistake of the resolver connections

6.4.2 Electromagnetic Tolerance (EMT)

In General

To monitor and control motors, the mains voltage is stored in the DC-circuit of the PMC-2 by means of AC/DC conversion. This stored energy is fed to the motor by deliberately switching on and off six semiconductor switches. The steep rise and fall of the voltage puts high demands on the insulation strength of the motor winding. Another essential aspect to be considered is **E**lectro **M**agnetic **T**olerance (EMT) with other system components. The flank steepness of the tacted voltage generates harmonic oscillations of a great intensity, up to in the high-frequency range.

Therefore the following EMT rules must be observed

- Choose the earthing option with the lowest-possible ohm rate (e.g. unpainted mounting board of the switching cabinet) for installation
- Contact on the largest possible surface (skin effect). If necessary, remove existing paint to achieve large-surface contact.
- From the **C**entral **E**arthing **P**oint, lay earthing wires to all connections in a star structure. Earthing loops are not allowed and can cause unnecessary distortions
- Use shielded cables only
- Only large-surface shield transitions are allowed
- It is not allowed to contact shields via PIN contacts of connector plugs
- By all means observe switching proposals
- Cut motor cable to minimum length
- Do not lay cable loops in the switching cabinet

Installation

CAUTION	The following installation rules must be observed to avoid the consequences of excessive distortion effects as far as possible.

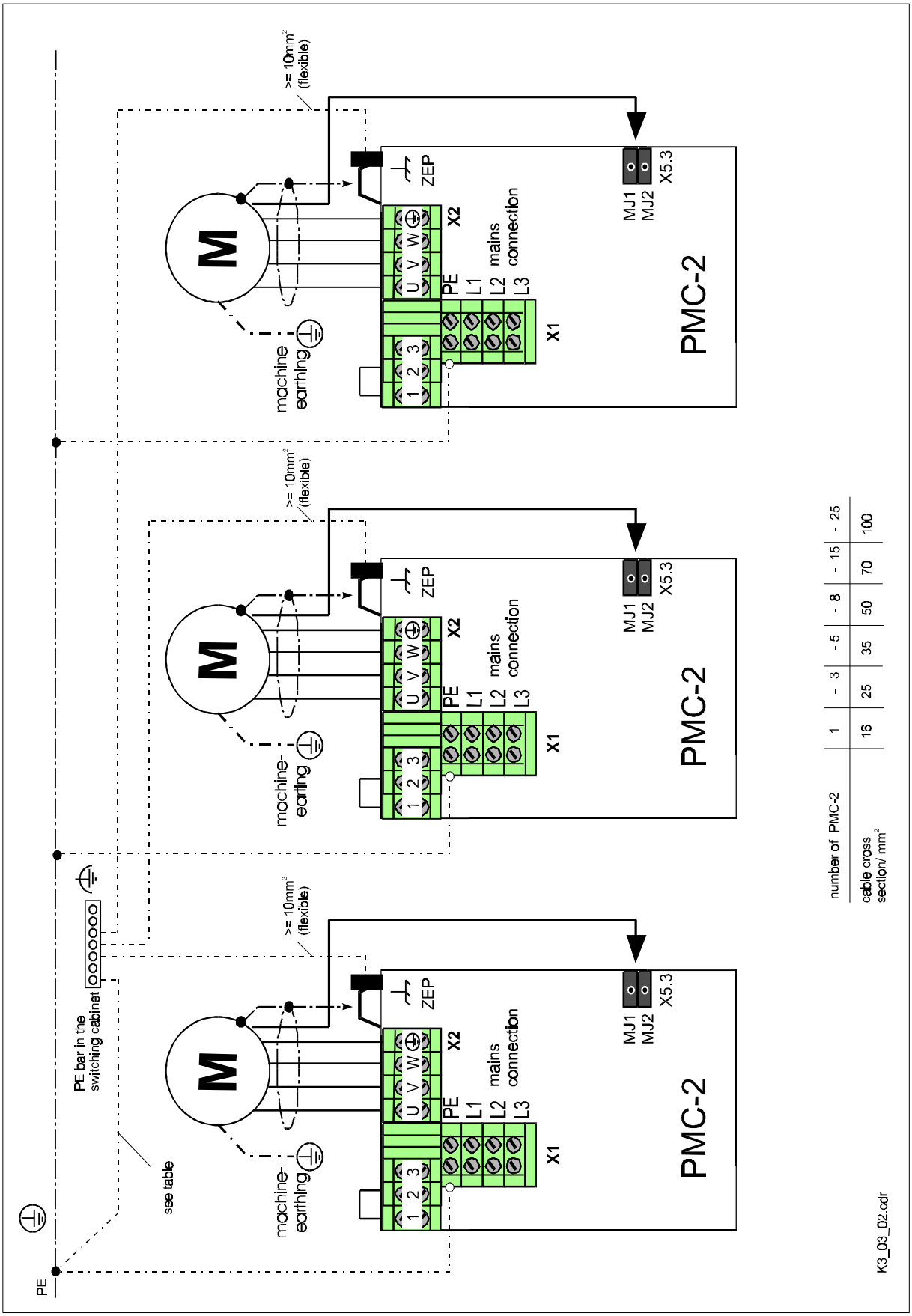
In connection with electronic controls, no inductive loads whatsoever may be switched without suitable distortion.
For DC operation, suitable interference shielding can be achieved by arranging recovery diodes. For AC operation, commercially available erasing elements matching the connector type can be used.
Only the shielding element mounted immediately at the point of inductivity serves its purpose. In any other case, the switching pulse may even emit increased interference via the interference shielding elements. It is much easier to avoid sources of interference in the first place, than to eliminate the effects of existing interference.
In no case must the contacts switching unshielded inductive loads be installed in the same room as the PMC-2; the same goes for cables carrying unshielded, switched inductivity and cables running parallel to them. The control must be separated from such „distorters“ by a Faraday cage (own section in the switching cabinet).

Motor cable	0 - 10m	10 - 20m	20 - 40m	over 40m
SB056		(up to 25m)	(up to 50m)	Application
Mains filter	no	FI07838	FI07838	specific filters
Motor filter	no	no	FI07837	(from 50m)
SB070		(up to 25m)	(up to 50m)	Application
Mains filter	no	FI07838	FI07838	specific filters
Motor filter	no	no	FI07837	(from 50m)
SB105				Application
Mains filter	no	FI07838	FI07838	specific filters
Motor filter	no	no	FI07837	
SB145 with PMC-2/8A				Application
Mains filter	no	FI07838	FI07838	specific filters
Motor filter	no	no	FI07837	
SB145 from PMC-2/16A				Application
Mains filter	no	FI07841	FI07841	specific filters
Motor filter	no	no	FI07840	
SB205				Application
Mains filter	no	FI07841	FI07841	specific filters
Motor filter	no	no	FI07840	

Notes:
For groupwise shielding, the common mains filter is dimensioned in such a way that I_{Nom} Filter ≥ Sum I_{Nom} PMC-2.
The motor filter must be installed above or on the side of the PMC-2.
The motor filter should be installed as close as possible to the PMC-2. For cable lengths of less than 0.5 m between filter and PMC-2, no shielding is needed between filter and PMC-2. Twist the motor cable! Then the shield is guided direct from the motor cable to the CEP!

CAUTION	For cable lengths of more than 40 (respectively 50) metres, please contact our application department.

Shielding, earthing, potential compensation if several PMC-2 are wired



6.4.3 Mains Connection

Fuse protection of mains

CAUTION	The PMC-2 is connected directly to the 3 AC 400 Volt network. A mains filter is integrated in the PMC-2. In addition, the power supply must be safed by a power safety switch to protect the plant.

Rated current PMC-2	Power circuit breaker (e.g. by Siemens)	Setting range	Set value
2 A	3VU13 00-0ML00	6 ... 10 A	6 A
5 A	3VU13 00-0ML00	6 ... 10 A	6 A
8 A	3VU13 00-0MM00	10 ... 16 A	10 A
16 A	3VU13 00-0MP00	18 ... 25 A	18 A
25 A	3VU16 00-0MP00	22 ... 32 A	28 A

For several PMC-2 at one power circuit breaker, use the following formula for calculation:

$$I_N = 1{,}2 * \text{Sum\_of\_rated\_currents}$$

Example:
1 PMC-2/2A + 1 PMC-2/5A + 1 PMC-2 /8A
1,2 * (2A + 5A + 8A) = 18A
-> e.g. type 3VU13 00-0MP00 by Siemens with 18A set value

Note:
For wiring, observe the cable cross sections in relation to the current.

Fault current protective gear

Due to the integrated mains filter, the operational leakage current of the PMC-2 is higher than 3.5 mA. This results in incompatibility with general fault current protective gear!

According to DIN VDE 0160FI compatibility is not required for permanently installed appliances if the appliance bears a warning sign and the operating instructions point out the increased leakage current and one of the following conditions is met:

- The cross section of power circuit breaker is at least 10 mm^2 Cu
- The earth conductor is supervised by a facility which has an automatic switch-off for the case of an error.
- A second conductor, electrically parallel to the earth conductor, is laid via separate clamps. This conductor must meet for itself the requirements of DIN VDE 0100 part 540.

For further information see DIN VDE 0160 (EN 50 178)!

Mains contactor
For the dimensioning of the mains contactor, add up the rated powers of the connected PMC-2 and choose the next-larger mains contactor (appliance categories AC2 and AC3).

Example:
1 PMC-2/2A + 1 PMC-2/5A + 2 PMC-2 /8A
1 * 1,3kVA + 1 * 3,4kVA + 2 * 5,5kVA = 15,7 kVA
-> e.g. type 3TF45 by Siemens with 18.5 kW

Control voltage

The control voltage may be earthed.

The 24V DC for the control voltage can also serve other sinks. However, the tolerances for the 24V DC control voltage must be observed. This is particularly important for applications with inductivity (magnetic valves, brake, etc.).

Checking the control voltage with a voltmeter is not sufficient. An oscilloscope must be used in order to detect short-term gaps in the control voltage (e.g. when switching inductive sinks).

CAUTION	If the tolerances for the control voltage are not observed, the following errors may occur: • E588 control voltage low • WATCHDOG

Note:
For approx. 10 ms a switch-on current of approx. 10 A per PMC-2 occurs.

T1 operation

The operating mode T1 is to fulfil safety regulations at plants where work needs to be done in the danger zone (commissioning or testing of your plant). The T1 operation of the PMC-2 is based on VDI 2853. The maximum speed is reduced to 10% both in software and hardware terms. It is possible to drive the axle in manual or automatic mode. In software terms the restriction refers to P0.01 V_max.
The DC-circuit voltage is reduced to a maximum of 10% of the rated voltage by a separate feed. The lower DC-circuit voltage in T1 operation efficiently restricts the speed. For safety reasons, the T1 contactor and the mains contactor must be locked (see 3.4). The DC-circuit voltage must be controlled externally by a voltage monitor, since the discharge time of the DC-circuit without DC-circuit short circuit is >1 min, and the DC-circuit must be discharged for switching.

	Mains input	DC-circuit voltage
Normal operation	3*400V AC	560V DC
T1 operation	10 - 40V AC	14 - 56V DC

Dimensioning of the transformer for T1 operation:

The transformer must be safed primarily and secondarily.

The current for which the transformer voltage is to be planned is influenced by several factors:

- friction
- motor
- pending loads

The main point for calculating the current usually is the friction within your plant in T1 operation.

If the current is known, the required transformer voltage can be calculated by approximation. The transformer voltage should be within the range of 10V AC to 40V AC.

$$U_{DC\,circuit} = EMC * \frac{max\_speed}{10} + 2 * R_{Motor\,winding} * I_{max\_10} + 10V$$

$$U_{Transformer} = \frac{U_{DCcircuit}}{\sqrt{2}}$$

The current for which the simulated transformer capacity must be set is calculated by the maximum permissible revolution torque.

$$I_{max\_M} = \frac{M_{max}}{KM_{20}}$$

$$U_{DC\_max} = 2 * R_{Motor\,winding} * I_{max\_M} + 10V$$

$$U_{Tr\_max} = \frac{U_{DC\_max}}{\sqrt{2}}$$

$$S_{max} = U_{max} * I_{max\_M}$$

EMC	EMC_constant	(see chapter 10 SB motors)
max_speed	P4.03 Max_speed	(20% more than rated motor speed)
$R_{Motor\ winding}$	P4.06 W_Resistance	
KM_{20}	torque constant at 20°C(see chapter 10 SB motors)	
I_{max_10}	maximum motor current at 10% of max_speed	
M_{max}	maximum permissible torque	
I_{max_M}	maximum motor current at M_{max}	

Example:

Given: motor type 1053002 I_{max_10} = 0,25 A M_{max} = 2 Nm

Wanted: $U_{Transformer}$
$S_{Transformer}$

Solution: From chapter 10:

- EMC = 0,098 V/RPM
- max_speed = 3600 rpm
- $R_{Motor\ winding}$ = 9,205 Ω

$$U_{DCcircuit} = 0{,}098\frac{V}{rpm} * \frac{3600rpm}{10} + 2 * 9{,}205\Omega * 0{,}25A + 10V \approx 50V\ DC$$

$$U_{Transformer} = \frac{50V}{\sqrt{2}} \approx 35V\ AC$$

$$I_{max\_M} = \frac{2Nm}{1{,}63\frac{Nm}{A}} = 1{,}2A$$

$$U_{DC\_max} = 2 * 9{,}205\Omega * 1{,}227A + 10V \approx 33V\ DC$$

$$U_{Tr\_max} = \frac{33V}{\sqrt{2}} \approx 23V\ AC$$

$$S_{max} = 23V * 1{,}2A \approx 28VA$$

Result: A transformer with a rated voltage of 35V AC and a simulated capacity of 28 VA maximum is needed.

6.4.4 DC Circuit

In the PMC-2 the AC-DC conversion of the power supply and the storage of the electrical energy takes place in the so-called DC-circuit. The DC-circuit consists basically of an AC-DC converter and capacitors. In the PMC-2 the DC-circuit voltage is applied to the power connector plug X1.

CAUTION	The DC-circuit voltage can be up to 735V! Make sure that the cables are sufficiently insulated! The DC-circuit must not be earthed!

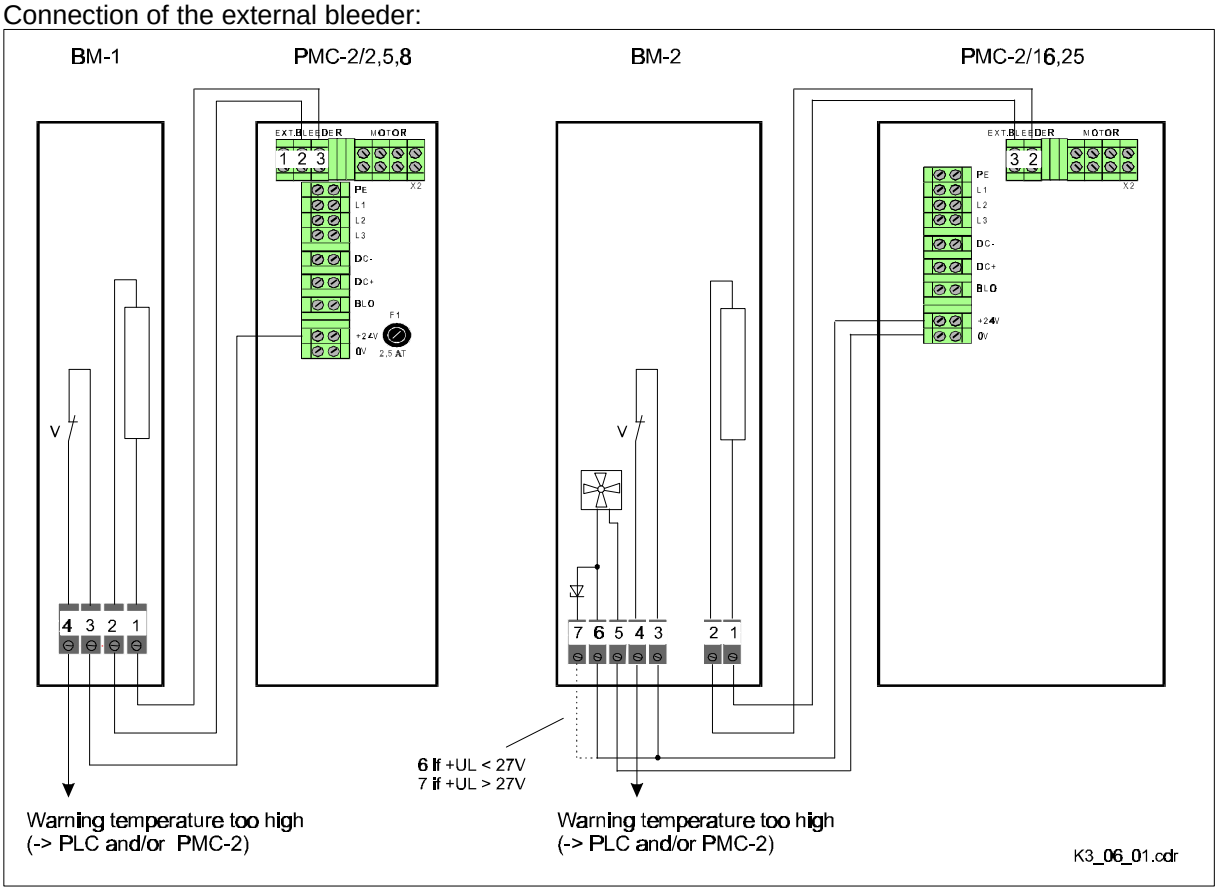
DC-circuit voltage restriction

In brake operation, he servo motor acts as a generator and feeds back energy to the DC-circuit via the motor DC-AC converter. The energy is stored in the DC-circuit capacitors, which causes the voltage in the DC-circuit to rise. If the capacity of the capacitors is no longer sufficient to consume the energy incurring, it must be made sure that the DC-circuit voltage does not get too high.

The voltage monitor checks the DC-circuit voltage and switches the DC-circuit to a bleeder via a power transistor if a certain limit (approx. 735V) is exceeded. The bleeder transforms the brake energy into heat. If the DC-circuit voltage drops below the lower switching limit (approx. 700V), the bleeder is switched off again.

CAUTION	When the maximum braking power is used, the air outlet temperature of the bleeder module may be > 100°C

Connection of the external bleeder:



DC-circuit short circuit

With relatively simple means, this function achieves a high safety when bringing the drive to a standstill. The monitoring functions built into the driving system are used the most efficiently.

In case of EMERGENCY OFF, enable LOW and severe PMC-2 errors, the mains contactor drops and the DC-circuit short circuit contactor falls in after a certain deceleration time (parameter 0.16). The DC-circuit is then discharged via a bleeder. Thus the motors are always stopped in a braked manner.

- The CD-circuit short circuit is active for at least 250ms, so that the complete discharge of the DC-circuit is guaranteed.
- The bleeder resistance must be at least 10Ω.

We recommend a resistor BM-1 or BM-2 in the size of the bleeders (see technical data) for single units and a BM-2 with 10Ω (article number: 13270010) for parallelly switched DC-circuits.

- The contactor K3 must be sufficient for the peak discharge current; its two normally-closed contacts must be switched in series.

We recommend the type Telemecanique LP1-D 25008 / 24V (article number: 17189003-002) or. LC1-D25008 / 230V (article number: 17189003-001).

Additional capacities at the DC-circuit

Additional capacities increase the energy stored in the DC-circuit.

- For plants which require acceleration and deceleration in short intervals, this may be necessary to reduce the continuous bleeder operation and thus the leakage heat.
- For plants in which the motor needs to complete its movement after cessation of the power supply, the capacitor module can provide the required energy.

For appliances with a rated current of up to 8A, the capacitor module KM-1 is available for this purpose.

CAUTION	If you would like to use additional capacity at the DC-circuit, please contact our application department.

Bridges of the DC-circuits

For multiple-axis applications, the DC-circuits of up to 4 individual PMC-2 can be bridged for energy exchange.

For this purpose, the PMC-2 are coupled via the DC-bus. The clamp BLO as well as the mains feeds L1, L2 and L3 must be bridged between all appliances. The common mains contactor is addressed by switching serially the relay outputs ”O_mains contactor” of the parallelly switched appliances. Each appliance can have its own bleeder, or all appliances can have a common bleeder. The LED ”BLA” is addressed in all appliances.

CAUTION	• A maximum of four PMC-2 can be switched parallelly. • The mains feed is on the appliance with the highest capacity. • The DC-circuit short circuit is on the appliance with the highest capacity. • In case of a common bleeder, the bleeder is connected to the appliance with the highest capacity. • For appliances without external bleeder, the parameter P0.25 ”Bleeder” must be set to ”no”.

CAUTION	BLO, DC+ and DC- must all be bridged in all cases. (e.g. only mains and BLO is not allowed)

If the option DC-circuit short circuit is used, the contacts ”O_DC_short circuit” must be switched in series (see K7 in the following picture).
For T1 operation the digital outputs must be connected to auxiliary relays (K5). (The contacts of the auxiliary relays must be switched in series to the coil of K2. -> see 6.4.5.2 ”The Control Circuit ”)

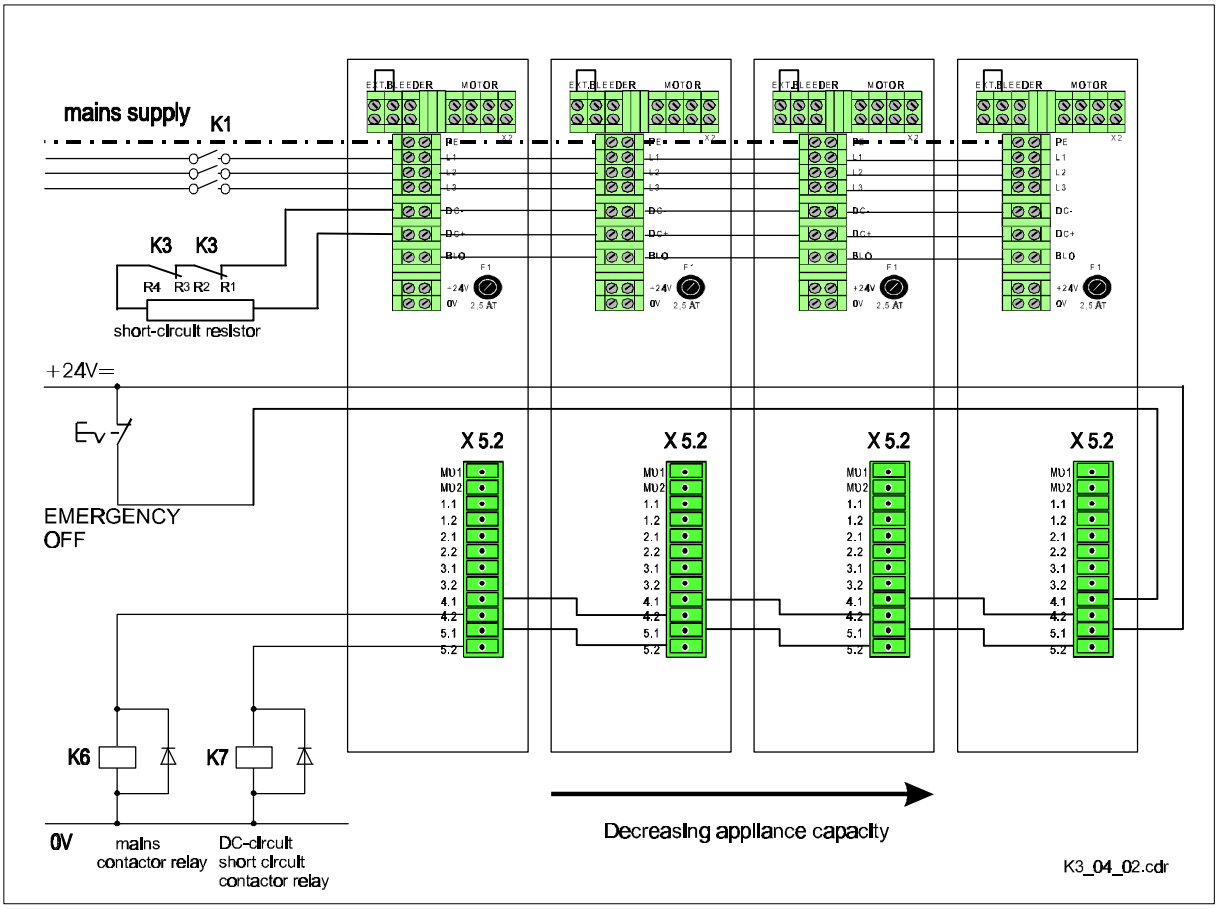
-> see also 6.4.5 Wiring of the PMC-2 in the System

Depending on the application, bleeders for individual appliances may not be necessary. The following points need to be considered:

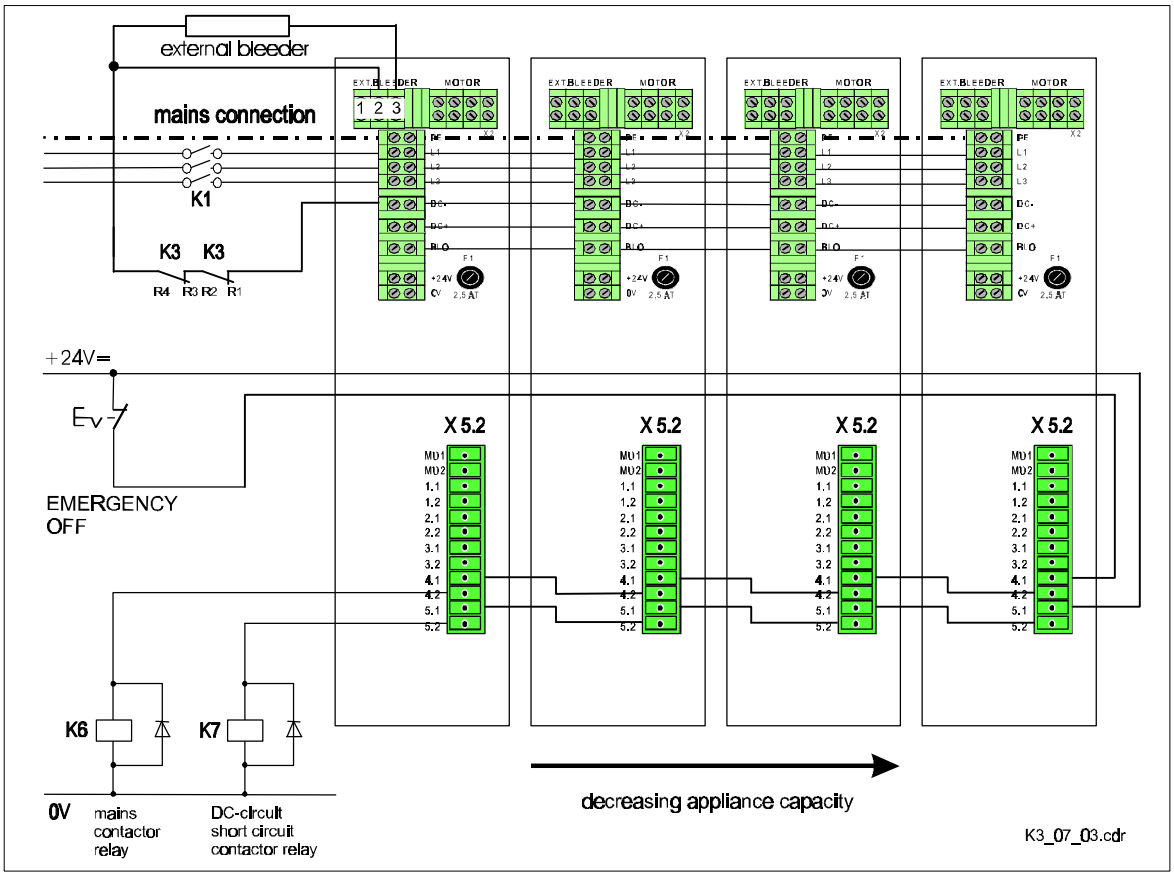
- The bleeder transistor of the individual appliances is desgned for the minimum resistance stated in the data sheet. It must not be lower than this value.
- The bleeder resistance resulting from switching parallel or omitting individual bleeders must be dimensioned in such a way that
    - it can destroy the peak brake power of the parallelly switched PMC
    - it can destroy the permanent brake power of the parallelly switched PMC without overheating.

Note:
In parallelly switched PMC-2 the times P0.07, P0.16 and P0.17 should be equal, since otherwise the behaviour is determined e.g. by the shortest time P0.16 for switching off and the longest time P0.16 for switching on.

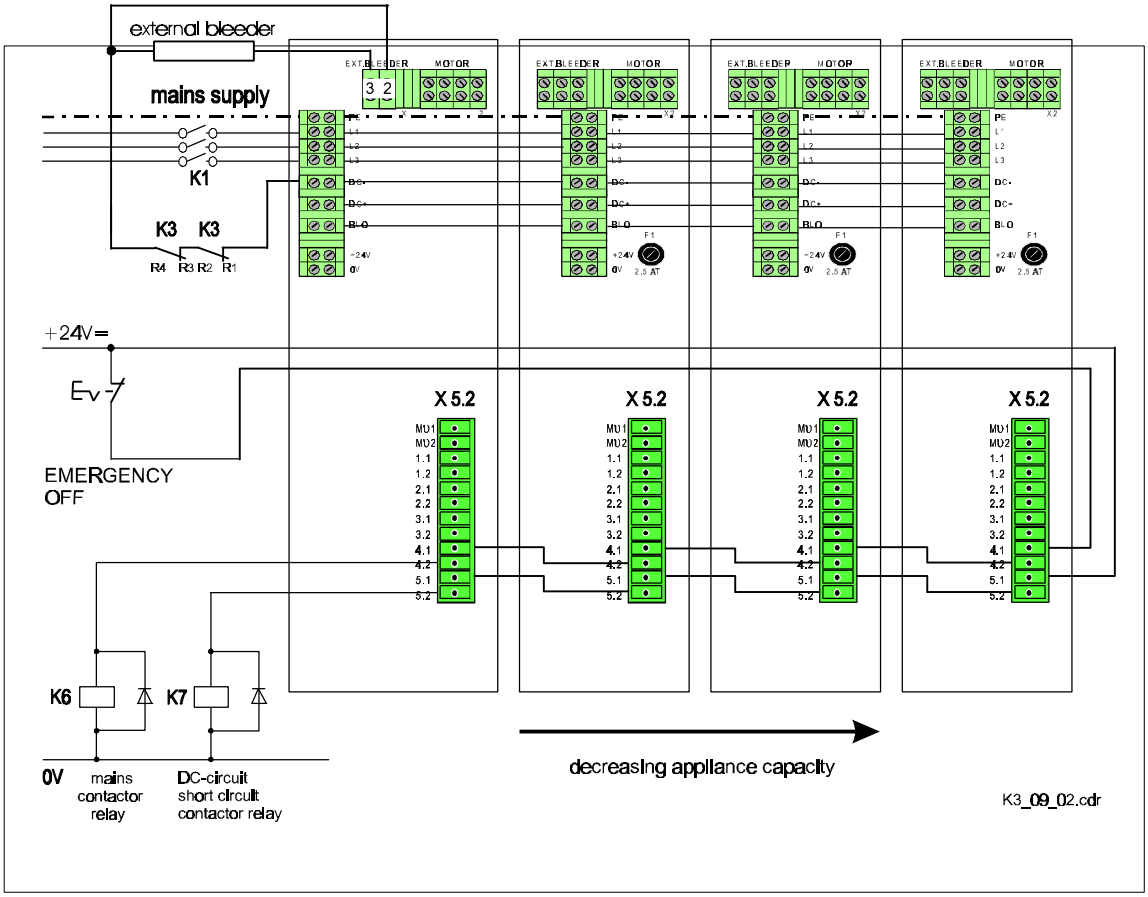
Wiring (appliances with internal bleeder):



Wiring (external bleeder): Bleeder is at the same time DC-circuit short circuit resistance

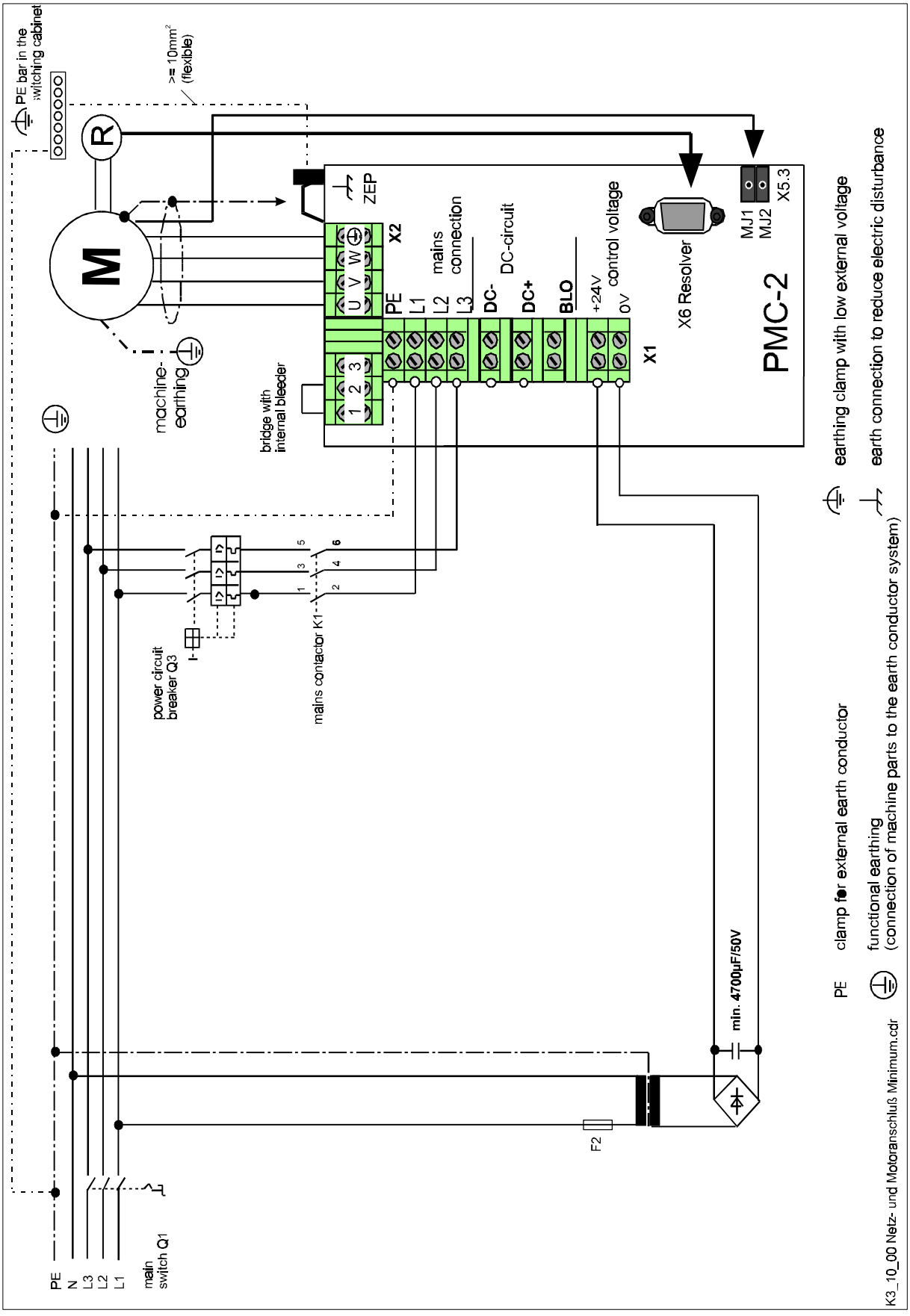


Wiring (external bleeder): as above, but with connection to 16A or 25A compact appliance

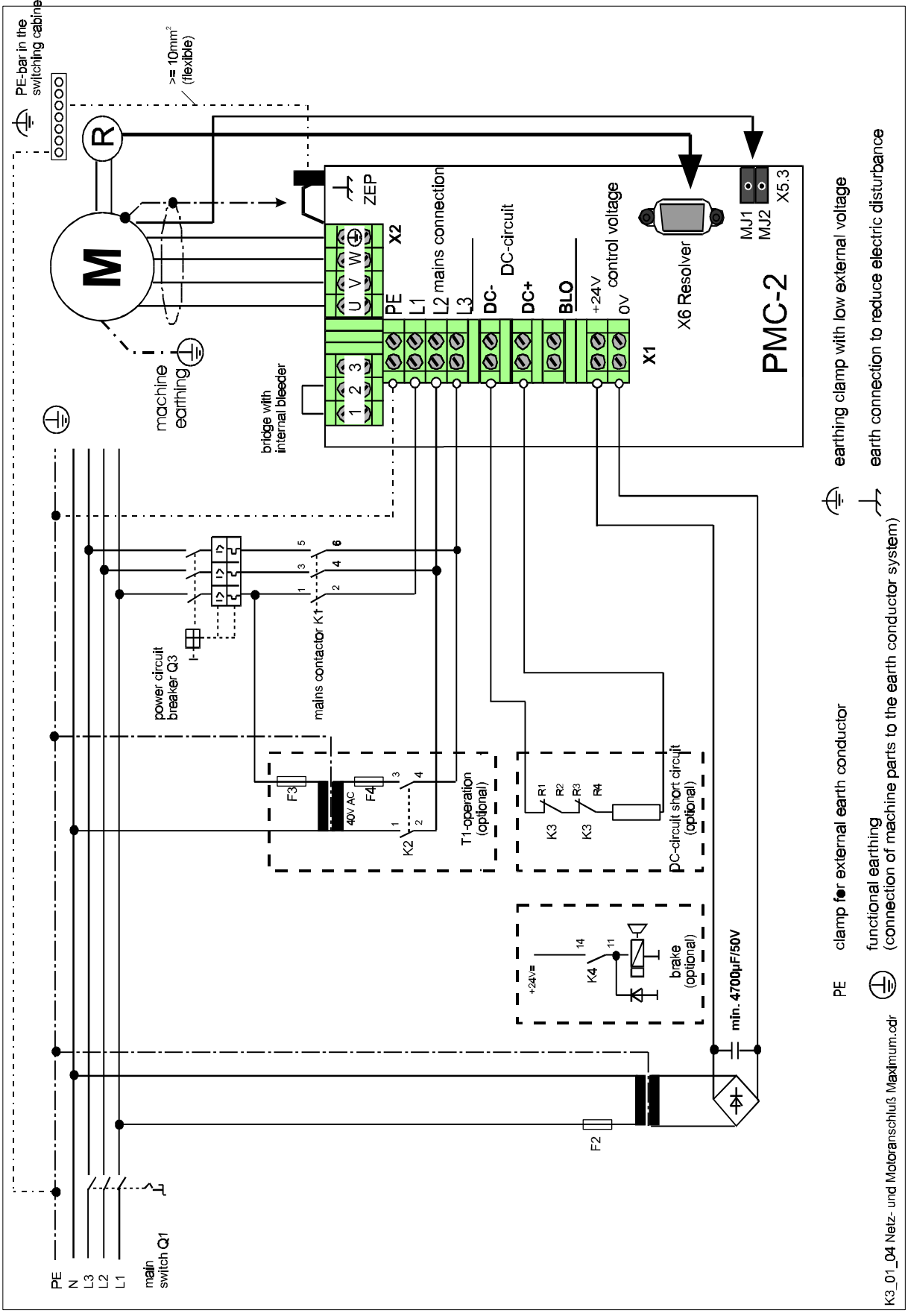


6.4.5 Wiring of the PMC-2 in the System

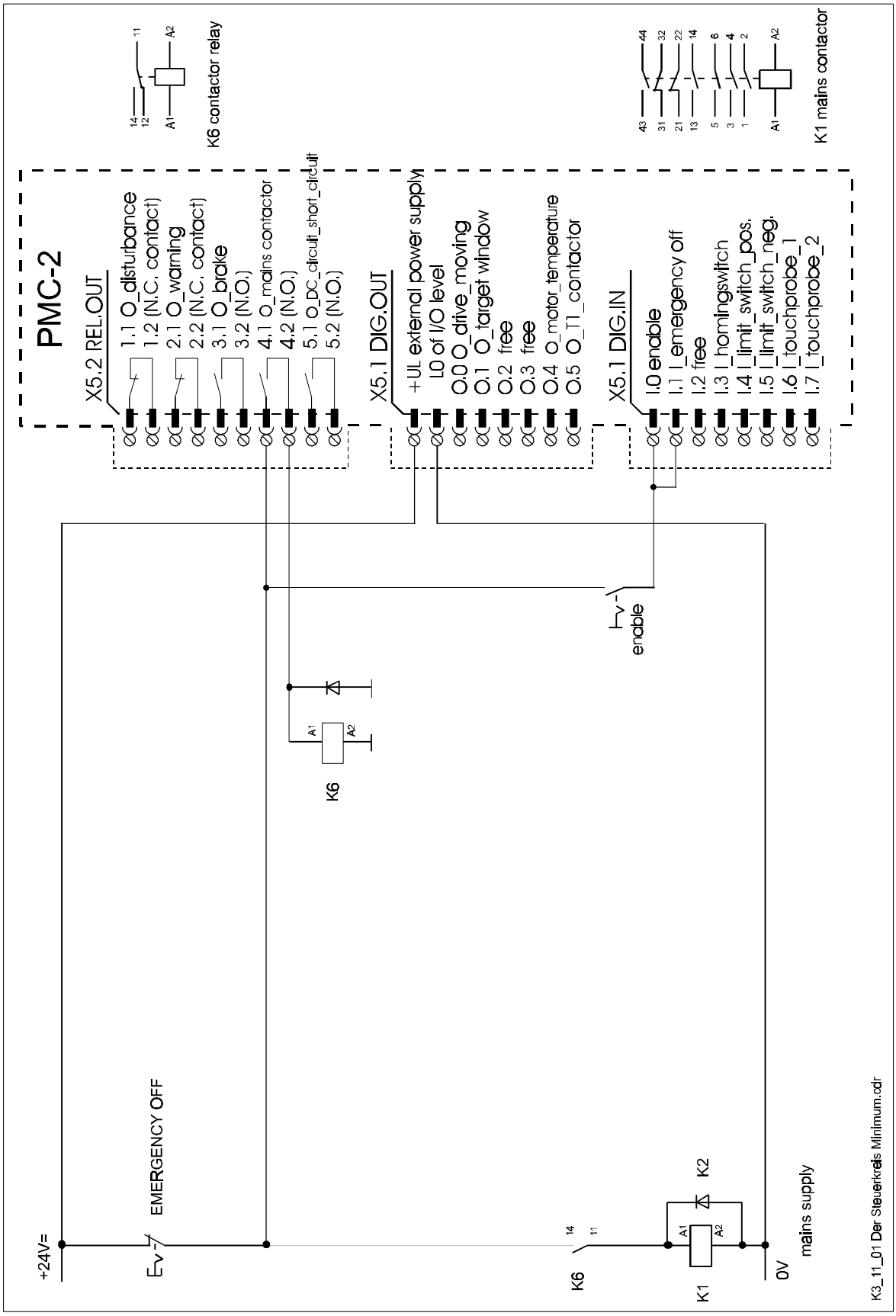
6.4.5.1 Mains Feed and Motor Connection



Maximum wiring in the load circuit



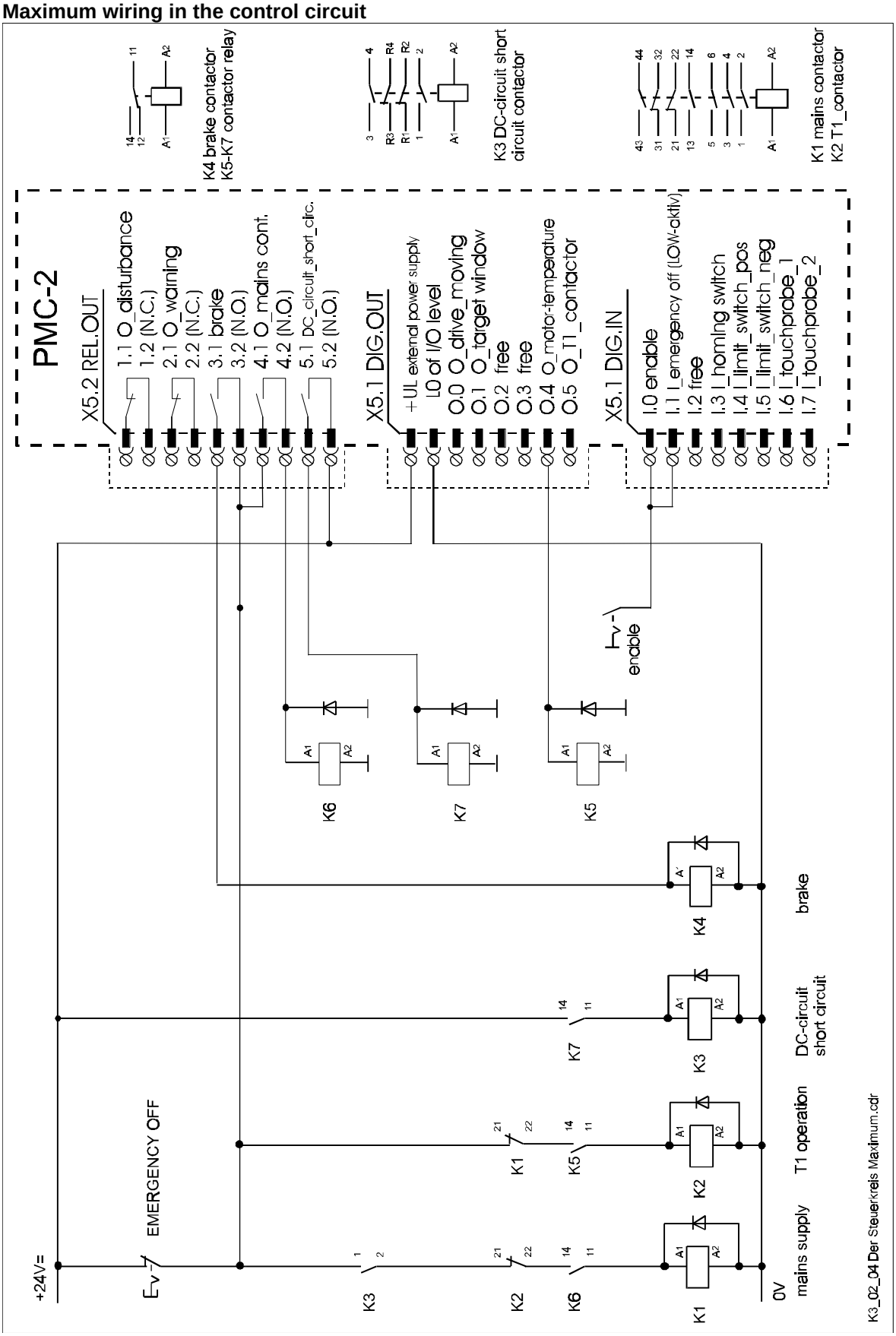
6.4.5.2 The Control Circuit



Note:

The auxiliary contactor K6 can be omitted if the operating current of K1 is < 200mA.
No additional external lock must be active when switching enable.

Maximum wiring in the control circuit



Note:

The auxiliary contactors K6 and K7 may be omitted if the operating current of K1 and K3 is < 200mA. No other external lock must be active when switching enable.

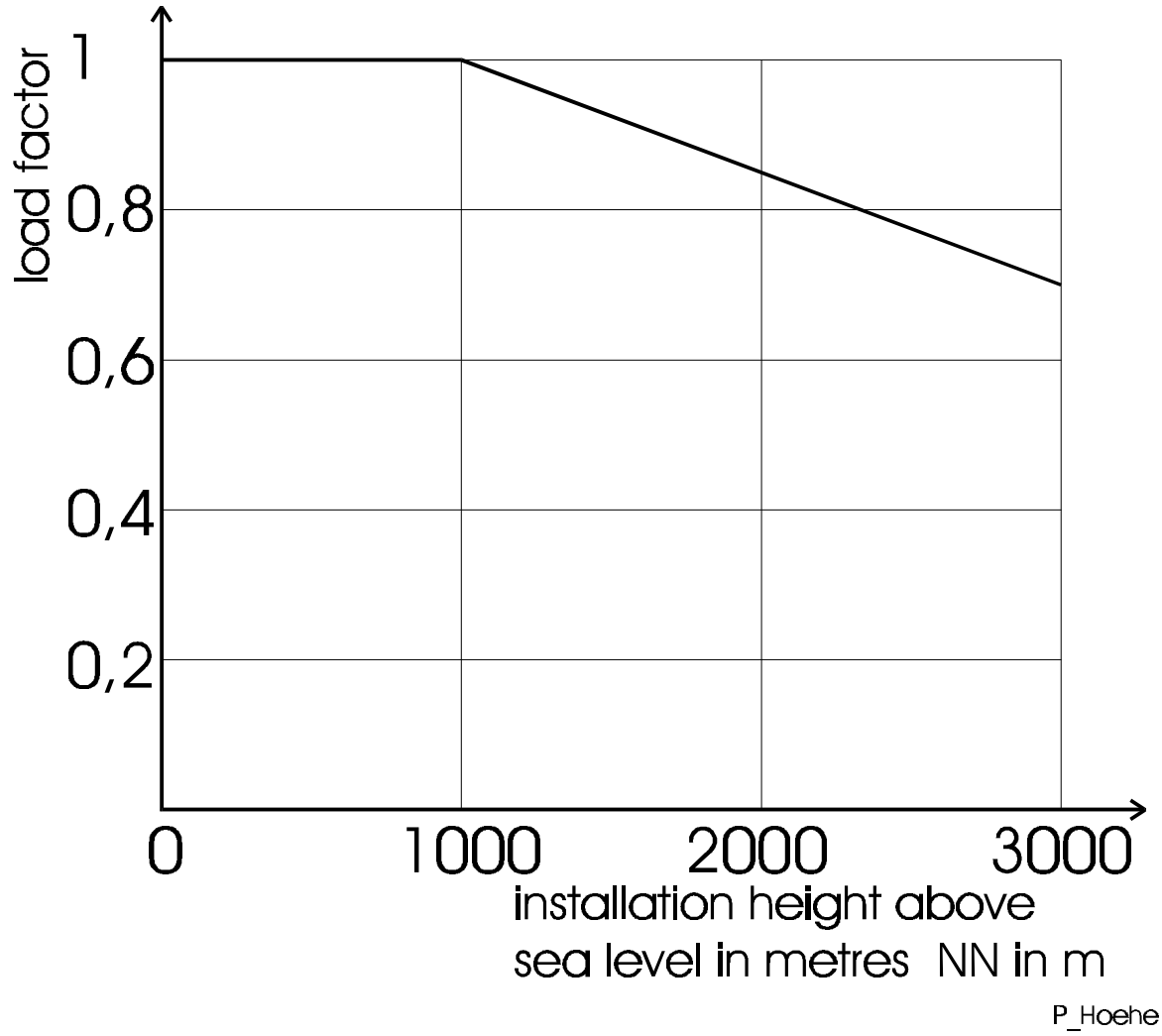
7 Special Conditions

7.1 Power Reduction at Increased Surrounding Temperature

The maximum permissible surrounding temperature is 45° C.

7.2 Power Reduction at Low Air Pressure

Below a height of 1000 metres above sea level no power reduction is necessary. Above 1000 metres the maximum output current must be reduced according to the diagram shown below.



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